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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 9 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire-fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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THE HELICOPTER—A NEW FACTOR IN FIRE CONTROL

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Foresters, in their effort to manage wild land more efficiently, have been continually envious of and wishful for the ability of the bird: to travel swiftly; to see rough terrain at close range, but in perspective; to hover and to alight in small spaces. Who wouldn't want to make more useful use of time, avoid leg weariness, and bypass the discomfort of an ill-fitting saddle and a bum horse? In none of the activities of a forester does this need assume greater significance than in the field of fire control. Small wonder then that some, and especially those charged with fire control work, have followed with avid interest the development of rotary-winged aircraft during the past half generation. Here is what they watched:

Developmental History

1922—United States Army makes its first helicopter take-off and landing.

1929—Autogiro Co. of America formed, produced a rotary-winged machine—used largely in the advertising field.

1931—Helicopter reaches height of 500 feet—horizontal speed of 50 miles per hour. (A prospect.)

1931—S. A. Nash-Boulden, supervisor of Los Padres National Forest, made partial flight over his forest in autogiro, believed to be first flight by forest officer in rotary-winged craft. Prophesied success.

1935—Army Air Corps purchased two autogiros for purpose of laboratory and flight testing. Proved successful for artillery fire direction operations. (Encouragement.)

1937—German helicopter reaches elevation of 11,700 feet, speed of 68 miles per hour. (More encouragement.)

1938—Army Air Corps starts school for autogiro pilots.

1939—Sikorsky develops successful helicopter.

1939—Army Air Force switches to helicopter. It is of interest to know that Dave Godwin was Forest Service member of the committee that made this decision.

1942—Sikorsky demonstrates helicopter, proves it to be a feasible machine; 5,000-foot elevation, 78 miles per hour. Made 761 mile cross-country trip. Its potential value in fire detection and suppression recognized by staunch advocators.

1943—Helicopter used by Army to transport wounded from jungles of Burma to base hospital. (A lift to proponents.)

1944—Sikorsky Aircraft now operating helicopter production line.

1944—Lacking facts as to mountainous services, western regions prepare transportation plan based on predicted helicopter transportation probabilities.

1945—Forest Service and Army Air Force in collaboration test use of helicopter in mountainous areas. (Has possibilities with skillful pilots.)

1946—Helicopter used in a limited way, but successfully, on Castaic fire, Angeles Forest. (Punches pulled due to theoretical limitations.)

1947—Helicopter used as key working tool on five major fires in California national forests. (Pilots went "all out" to give service.)

This chronology might lead to conclusion that the course of rotary-winged aircraft development and adaptation to the problems of transportation and supply service in mountainous areas was one of smooth sailing. Such was not the case. Many discouragements confronted the inventors and proponents of the machine, as test model after test model disclosed flaws of mechanical design, displayed impractical ideas as to load and elevation limitations, and a myriad of similar disappointments. The handful of foresters who, over the long years of its developmental infancy, daringly visioned and voiced their belief in the successful adaptation of the helicopter to forest fire control steadfastly faced skepticism of their co-workers.

Three people (Pat Thompson, Dave Godwin, and Ted Norcross) got their dander up. Action started. In 1944 an analytical study was undertaken of the feasibility and cost of helicopter transportation as compared to costly roads in fire control work on certain selected forests (Circular E–2963). The study, while based on theoretical operation costs and performance hoped for but not yet attained, served two purposes: (1) It indicated that helicopter transportation, if it met expectations, would result in better fire control at lower cost, and (2) it stimulated interest in the study of the new type of aircraft.

At that time there was little factual information as to the performance of these machines under the conditions of wind, topography, and elevations common to the forested land of the West. As a matter of cold fact, all conceptions as to mountain performance were speculative. There had been no tests.

Testing for Mountainous Forest Fire Control

Gen. H. H. Arnold, Chief of the Army Air Force, had, from almost the beginning of his career, been deeply interested in the aerial phases of forest fire control. He served as one of the earliest of fire-reconnaissance pilots. This interest in 1945 lead to the Army Air Force and the Forest Service joining in a series of helicopter tests under western forest conditions, using Air Force "Sikorsky" machines and skilled Air Force pilots. The Angeles and San Bernardino Forests were selected as proving grounds for these tests. March Field, internationally known and "Hap" Arnold's old command, was the operating base. The tests included, among other things, determination of the allowable pay loads which with machines of the type tested (Sikorsky R–5) would permit safe landing and take-off under varying conditions of flight distance, altitude, temperature, wind velocity, and weight dis-

tribution. The findings of these tests are reported in the January 1947 issue of FIRE CONTROL NOTES. Significantly, the machines were demonstrated to be (within their limits) feasible working tools for reconnaissance, supply and personnel transport under mountain conditions.

In 1947 two privately owned Bell model 47–B helicopters moved into southern California. Immediately arrangements were made by contract to run these through the same tests as given the Sikorsky machines. Results were satisfactory. A full report of these tests will appear in FIRE CONTROL NOTES.

The Pay-Off

An Army Force Sikorsky model R–5 was used for reconnaissance and a small amount of supply dropping on the Castaic fire in 1946. It did all that it was asked to do, but it worked under the "tight wraps" of the test conclusions. Nobody stepped out into the field of "what can the damned thing do?"

The golden opportunity for a test of positive performance under trying field conditions came with the Bryant fire on August 5, 1947. This fire started in Big Tujunga Canyon of the Angeles Forest, which is an area characterized by very high watershed values, considerable home investments, rapid rate of fire spread, and steep, inaccessible country. Further, the fire was a direct threat to all of the suburban development on the north side of Los Angeles. The Forest Service was not disposed to leave any possible resource unused. There were available the two Bell helicopters owned by the man who had participated in the earlier tests of the Bell and who was very much interested in proving the worth of the helicopter. These were pressed into service.

Two of the primary physical factors affecting the performance of helicopters which were encountered exceeded substantially the conditions of the earlier test operations. Temperatures were up to 107 degrees as compared to the 100-degree temperatures under which the tests were conducted, and elevations were operated successfully up to 5,400 feet as compared to the 3,500-foot elevation which was felt to be about the upper limit under the test conditions. Wind, a third important factor affecting the performance of the machine, was, of course, variable but generally exceeded the 0 to 5 miles employed under test conditions. With this set of conditions, and with two helicopters, two willing, skilled, and courageous pilots, and an experimentally minded fire manager, a fresh chapter in fire suppression history was written.

Successful undertakings on the Bryant fire, which were later duplicated on the Cleveland, Eldorado, Mendocino, and Tahoe Forests, establish the place of the helicopter in fire suppression.

1. The fire boss and his two zone bosses by helicopter personally investigated ground conditions, action strength, and fire behavior requiring major decision in strategy and tactics and without delay and with complete mutual understanding converted strategy to action. It is certain that without this coordinated and on-the-line size-up of the situation the usual lags in action and debating of decisions incident to a large fire would have occurred. This complete coordination could

Fire scouted by helicopter. Note ease with which manpower and tool requirements can be determined.

Typical section of line showing ease of transporting key overhead to critical portions of line.

not have been attained through use of legs, horses, or cars. The lines were too long and country too rough to accomplish a complete size-up quickly by orthodox methods.

2. The line boss, responsible for execution of control action in an area which could be covered once by conventional method in not less than 12 to 14 hours, was able to give on-the-ground (this literally) supervision to division bosses several times during the shift.

3. The Scouting and Plans organization with two flights per day obtained more timely information on which to base fire behavior estimates and control force requirements than would have been possible with three to five ground scouts working from daylight to dark.

Note detail with which ground cover can be observed from helicopter for Scouting and Plans organization.

4. The service and supply chief was able to visit secondary bases of operation once each shift and provide the constructive advice so often lacking to this group in the fire organization. As a result of such visits, overstocking of supplies was avoided and distribution of scarce strategic items on the basis of actual need was assured.

The value of the helicopter in the field of service and supply is further indicated by these typical incidents:

(*a*) Eighty fresh personnel were placed on one division by helicopter in 3½ minutes per man as against 3½ hours by ground travel. Half of the crew were active on the job in 1¾ hours, compared to the whole worn-out crew in 3½ hours. Absence of fatigue and resultant high morale paid off in the form of at least a doubled rate of line con-

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Six skilled fire fighters landed here and were able to hold fire on this ridge. Landing spot 8 by 8 feet, elevation 3,600 feet.

struction. Active action on the line started within 4 minutes after the first man (the division boss) took off and stepped up progressively from then on. Also, the helicopter and its first passenger beat the proverbial "cock's crow" signal of dawn by a few minutes. This may or may not have been risky, but the old red rooster drooped his tail feathers the rest of the day. This crew was based on the line (actually) for 1½ days and subsisted with hot meals, lunches, and water from the base camp by helicopter. They finished their assignment in a happy mood.

(*b*) Men were needed, urgently, on a strategic hot spot in a remote and almost inaccessible situation. The first man was on the line 15 minutes after the need was discovered; 1 hour later the sixth man arrived. The helicopter had found a usable 2 by 4 landing spot. By conventional methods these men would have arrived not less than 6 hours after the need was known, worn-out by hiking, and probably too late to have been effective.

(*c*) A need developed for additional leaders to direct a snag felling operation. Plenty of workers, but green hands, were on the line. The extra leaders required were on the job, by helicopter, within 10 minutes.

(*d*) Extra saws and felling tools were needed for this job: another 7-minute mission for the bellhop of the skies.

(*e*) A truck tipped over, 25 men were injured, 3 seriously; 2 hours by road to the nearest doctor or hospital, 4 hours round trip. The helicopter had the last of these 3 seriously injured men in the hands of a doctor 45 minutes after the accident was reported. Landing spot was on an "out curve" on a 9-foot truck trail.

(*f*) Back-pack pumps and water were urgently needed—2 hours walking time from the nearest road. The first of these was delivered within less than 10 minutes after the order was placed.

(*g*) A critical situation requiring extra men, tools, and water developed on a sector. Pilot Knute Flint was asked to reconnoiter and report the nearest available landing spot. Within 5 minutes he was back. His need was a competent smoke chaser, an ax, and a pair of pruning shears. His plan: to hover low over the selected spot; throw out the tools; the man climb out, let himself down 5 feet, and clear brush clumps off a knoll top. During the clearing interval, 15 minutes, Flint would return for the needed supplies and start delivery. Mission was accomplished per schedule, and the sector held. The landing spot was within 3 minutes of the job to be done.

So much for the Bryant fire. When the results of this operation were summarized, it was found that the grit and skillful service with which field conditions were met were much more favorable to operation of the helicopter than was anticipated during the testing operations. Landings with full load were being made at 5,400 feet. Maybe this was on the dare-devil side, but it worked. Successful fire control has frequently had its genesis in dare-devil try.

In the language of the Angeles personnel, the helicopter had "shed its diapers" and had grown up to a full-fledged and effective worker. Following this performance the helicopter was used on the Cleveland, Eldorado, Mendocino, and Tahoe Forests on similar missions. In every instance the findings on the Bryant Canyon fire were substantiated, and in some cases exceeded. Tom Bigelow of the Klamath Forest, a veteran of 25 years of fire service, says: "After 25 years I have seen what I have dreamed of—a service that gets me and what I need there right now."

On the Allen Ranch fire (Eldorado Forest) the initial landing was made on the top of a lumber pile. On the Bloody Run fire (Tahoe Forest) landing was on a tiny sand bar in a difficult canyon, but a crew was supplied from this base for 2 days. These are accomplishments on going fires.

For the future, we believe that if the Forest Service does not embed itself in a shell of orthodoxy, including conventional plane service, the need for a large overhead organization on major fires, with many men serving Supply, Plans, and Line, should be a thing of the past. The justification for these have been the span of control limitations occasioned by the travel time between given jobs in the total operation. Planning control of the fire, for example, consists of gathering accurate and timely information on which behavior and control force requirements can be based. With one man covering in intimate perspective 10 to 40 miles of perimeter an hour, there is little need for time-consuming ground scouting as we have practiced it. In sharp contrast to the limitations of a plane, a helicopter can work with safety just a few feet above the ground cover and follow closely the profile of a fire's perimeter. Its action is precisely that of a vehicle following the ups and downs of a cross-country road in hilly country. Likewise, due to its ability to work "just above the tree tops," splendid, closely detailed observation results are had under smoke conditions that make plane observations or "across the gulch" ground observations wholly useless. It's also "aces" for spot-fire scrutinies. A close down hover or a couple of tight circles at a bad spot gives the answer.

In servicing fire fighters, elaborate secondary camps with the usual primitive and labor-consuming equipment and the temptation to camp at the water hole will go out of the picture. All the services such as cooking and tool reconditioning can be performed at a central point where the best of facilities are available and still accomplish the same end product—well-fed and well-rested men camped on the line.

Line supervision of control work has to date been territorally assigned on the basis of walking or saddle-horse time to attain the required frequency of supervision. The helicopter can provide this frequency in one-twentieth of the time. This would indicate that when we know how to use the machine one man can adequately supervise the top line work on any fire situation which we have experienced in recent years. His big need will be a stenographer, a radio, and a loudspeaker.

The need for division boss caliber supervision is due to the inevitable occurrence of localized critical situations at numerous points along the fire perimeter. With a continuously current observation coupled with a means for depositing this caliber of man where needed and when needed, the half-mile "division" that has been necessary in some of our more rugged terrain will go out of the picture. Just what this will add up to in terms of skilled personnel necessary for a specific operation is yet to be determined, but it is a certainty that if Les Covill, Tom Bigelow, Hi Lyman, Glenn Thompson, and their successors, don't have to use their legs to move their eyes and brains around they're going to be the boss men on a lot longer fire lines.

Interestingly, well over 200 men were transported by helicopter this season with but one objector. To the rest it was as welcome as a taxicab on a rainy day; in fact, several tried to develop hitch-hikes from line camp to home base. It's a mighty easy way of getting from hither to yon without getting leg weary.

The Future of Rotary-Wing Aircraft

Today we have the Bell Model 47–B which is a proven working tool when combined with sufficient pilot skill. A Sikorsky S–51 is capable of performing our job, but its production is so limited that its availability for suppression work is doubtful. What then can we reasonably expect in the near future? The surprising thing is how much can be accomplished with small capacity machines. We have thought in terms of four- and five-place ships. The little fellows have shown themselves to be producers. We can't afford to bypass them. The fact that development work is proceeding so rapidly is one reason that the present models are not being produced in greater numbers. Let's develop with the commercial development, but keep even or a pace ahead of it. Obsolescence is a real factor when dealing with a $20,000 to $70,000 piece of equipment. In the hopper at the moment are several different dual rotor craft that, if they meet claims, will provide an operating ceiling of 13,000 feet with pay loads up to 1,500 pounds. It is quite possible that the smaller type helicopter, which due to size alone is a more versatile machine, will be redesigned to permit spot landings and take-off at greatly increased ceilings.

Experts in the field of helicopter design believe the 25- to 30- passenger machines are well within the realm of possibility, but they are

going to lack the flexibility of the little fellows that can land on a dime. I'd count the big fellows out—they will require too much in the way of prepared landing spots.

The variety of uses to which the helicopter can be put is far from completely known. For example, more positive water bombing of free burning fires is a reality. Also, the whipping up of backfires by a rotor-inspired breeze, which was done on the Cleveland, and the retarding of a free-burning brush fire by kicking an adverse wind in its face, likewise an accomplished fact, open up a lot of speculative possibilities.

Let's give this machine the respect that is due, use it, and save a lot of our successors unresolved questions, achy joints, and sleepless nights.

Conclusion

Foresters cannot afford to overlook the helicopter in any plans for forest management involving reconnaissance, transportation of personnel, equipment or supply, or special project service, whether they be concerned with fire suppression, timber survey, snow surveys, range reseeding, tussock moth control, or road and trail studies. The helicopter, in good condition and with skillful pilots, while not a panacea for all our transportation and service problems, is a proven implement available for its proper place in the field of wild land management. Let's give it its place in our plans.

Dispatching Aids.—A method for recording data on going fires which should prove of assistance to dispatchers when lightning storms are in progress is suggested. A brief discussion of the proposal follows:

1. Cover the regular forest map of the area being affected by the electrical storm with plexiglass sheet and secure it to map with scotch tape.

2. Indicate on plexiglass by previously determined symbols—

(*a*) Location of each lightning strike likely to result in a fire.

(*b*) Time of discovery for each fire as reported by the lookout or lookouts.

(*c*) Rainfall showing whether light, moderate, or heavy.

(*d*) Number of men sent to the fire as they are dispatched, and time of departure.

(*e*) Whether there are sufficient men to handle the fire, whether more men are needed, etc., as determined from reports of initial attack men.

(*f*) Time and number of reinforcements dispatched.

(*g*) Report of control of a particular fire.

3. This graphic method will—

(*a*) Provide information on the path of the storm.

(*b*) Indicate the extent of precipitation, which will help the dispatcher to determine where his danger areas are.

(*c*) Help the dispatcher mobilize forces at desired locations and in numbers required to handle the situation.

(*d*) Provide the dispatcher with a picture of the location of each fire and the number of fires involved.

(*e*) Show the fires to which forces have been dispatched and the number of men involved, as well as follow-up forces required, when fires are controlled, those still giving trouble, etc.

(*f*) Prove of assistance in the development of a plan for follow-up detection, either aerial or lookout or both, after the storm.—H. S. Palmer, *Timber Management Assistant, Sitgreaves National Forest.*

ROVING FIRE POSTERS

Alan A. McCready

Staff Assistant, Harney National Forest, U. S. Forest Service

In the Black Hills area commercial trailers are often used for advertising, the trucker furnishing the space and the advertiser the materials and artistic skill. Many of these trucks cover a wide range of territory and are seen by a great many people. This seemed an effective way of putting over a fire-prevention message.

The Buckingham Transportation Co., who also have national forest timber contracts in South Dakota and Colorado, were first approached with this idea. They offered the use of a brand new 40-foot trailer. Its maiden run was to be to Minneapolis, after a trial appearance in the "Days of '76" parade in Deadwood; and runs to Denver and Ogden followed.

Harney fire prevention sign on the Buckingham trailer.

Several of the Harney people collaborated on the idea for the layout, and Forest Service painter Carl Wiehe, who has a flair for panoramic paintings, carried it out. About 10 different colors and shades of synthetic enamel, adapted for outdoor weathering, were used. The punch line was painted in bright red.

A second trailer, operated by Roy Bristol between Custer, S. Dak., and Denver, is now carrying a similar fire message, though with a different public appeal approach.

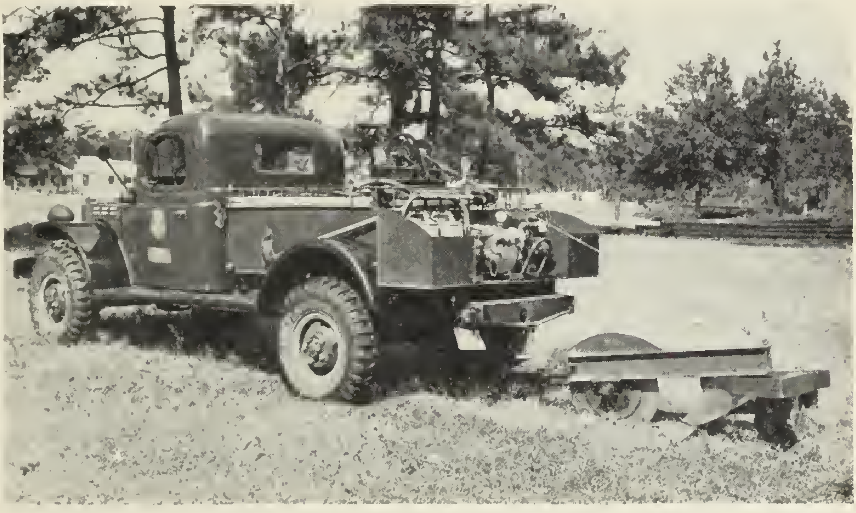
These large trailers are well suited to this type of advertising. The surface is expansive and usually unbroken, and the base paint is necessarily high-quality weather-resistant enamel. We know this way of plugging forest fire prevention gets across to the public by the number of favorable comments we have heard about it.

FLORIDA'S MOST MODERN FIRE TRUCK

Owen R. Douglass

Fire Control Chief, Florida Forest Service

To combat woods fires under the special conditions offered by Florida terrain, the Florida Forest Service has developed what we consider one of the best all around combinations, an all-purpose fire-line plow and fire-fighting vehicle.



Truck with middlebuster plow lowered by the hand-operated winch nearly to working position.

This is the 1-ton Dodge power wagon equipped with 9.00x16 mud and snow tires, and a front-mounted winch. It is the standard commercially manufactured truck to which has been added certain special equipment by the Florida Forest Service. Although rated at only 1-ton capacity, the truck has been loaded considerably beyond the 1-ton limit through the use of helper springs.

Limited experience in operating these trucks with heavy loads has not indicated that any particular trouble will develop. The trucks are purchased with cab and chassis only, then a 275-gallon specially constructed tank is mounted on the chassis. The tank weighs 800 pounds empty and 3,000 pounds filled. A compartment is constructed into the tank at the rear for mounting any auxiliary pump. The weight of the auxiliary pump and engine is about 200 pounds.

The plow, illustrated in the photograph, was designed and developed by the Florida Forest Service at Lake City during the summer months of 1947. It is a middlebuster plow capable of making a fire line approximately 4 feet wide under almost any Florida conditions.

It is a simply constructed plow, using the rolling coulter and middlebuster principle for operating. The plow is attached to the truck by a specially constructed draw bar mounted between, and fastened to, the rear of the frame. It is easily detachable. It is hinged both vertically and horizontally in order to allow it to be raised and in order to allow it horizontal leeway for tracking behind the truck when in the ground. A simple hand-operated cable winch is used for raising and lowering the plow. The weight of the plow is approximately 600 pounds. It is manufactured in Lake City and distributed from Jacksonville.

By using the low-range transfer case and four-wheel drive of the Dodge there is more than ample power for pulling the plow without overloading the engine.

Use of the plow during the actual suppression work saves much time in mopping up fires, and with the present scarcity and high cost of labor it is believed that the plow will more than pay for itself in one season.

This unit is located in St. Johns County, Fla., and indications are that the operation will be most successful.

A Simple Binocular Holder.—Many ingenious towermen with time on their hands think up a lot of good ideas but say nothing about it. On a trip through New Hampshire with Bill Branch of the Chief's office, we visited a tower which had a binocular mounted on the rear sight of the Osborne fire finder. Bill Emerson, lookout watchman at the Warner Hill Tower (near East Derry, N. H., for many years operated by the New Hampshire State Forest and Recreation Commission), gave birth to the idea which may be of use to others. Emerson made the device for his personal convenience, but it also appeared to be particularly useful in making a systematic search of the terrain.

The device is simple and cost of material should not exceed 50 cents. A light metal window sash pulley was cut off midway and attached to a ¾-inch wooden block about 4 by 5 inches in size. A light metal spring clip for holding the binocular in place was fastened on top of the woolen block. The open portion of the sash pulley fits over the rear sight of the alidade. The binocular support is adjustable which facilitates a systematic search of terrain between tower and horizon.—Edward Ritter, *Region 7, U. S. Forest Service.*

Dawn Patrol.—As one means of meeting the hunter fire problem, the Stanislaus National Forest in Region 5 has been using what is known locally as the "Dawn Patrol." One such patrol, actually an evening patrol, is made the afternoon and evening prior to the opening of the deer season. The rest are made on week ends and especially Monday mornings at dawn.

This prevention approach is simply a plan-wise method of assuring personal contact of every hunter camp to check the proper care of campfires, issue smoking warnings, and detect and extinguish unattended campfires.

The forest is blocked out into small natural units and every able-bodied man in the organization is assigned a unit. The units are balanced in size depending upon concentration of hunters and distance to cover. It usually requires from 2 to 4 hours to cover a unit.

On one Monday morning dawn patrol, eight unextinguished campfires were located and put out. In 1946 with 20,000 hunters, two fires were caused by unextinguished campfires. In 1947 one fire was caused by a campfire. In all three cases, the responsible parties had not been contacted by the patrol.—Neal M. Rahm, *Assistant Forest Supervisor, Stanislaus National Forest.*

FUNDAMENTALS OF FIRE BEHAVIOR

H. T. Gisborne

In Charge, Division of Forest Protection, Northern Rocky Mountain Forest and Range Experiment Station

[Used May 5, 1947, at 40-man Fire Boss School.]

Our job of fire control can be done, in fact has been done, in several ways: By brute strength and little attention to the conditions we are attempting to control; by observation of what is happening but with little or no understanding of why the fire is behaving as it does; or by practical application of knowledge of the basic laws of chemistry and physics that are actually determining the rate at which a fire is spreading. Let us look into the most significant factors that affect fire behavior.

FIRE IS A CHEMICAL PROCESS

Combustion is a chemical process. It is classified that way because combustion, with or without flame, is a molecular reaction in which molecules of oxygen in the air combine with molecules of cellulose and lignin (which make wood) and thereby change most of the solid into gases. These gases are molecules of different substances. They are no longer cellulose and lignin. Such changes of substance are chemical not physical processes. When these changes occur at such a rapid rate that heat and flame are produced the process is called combustion or fire.

When you look into the fundamentals of combustion and find that there are only three basic factors or three essentials to this chemical process it is obvious that we are overlooking a bet if we fail to consider each of these three things in our calculating.

Three Essentials of Combustion

Completely controlling the chemical reaction called fire are only three essentials. They are: (1) Fuel or something that will combine with oxygen rapidly enough to generate heat; (2) heat enough to raise that fuel to the ignition point; and (3) plenty of oxygen in contact with the fuel or with the gases evolved from the wood. Remove the fuel as we do when we dig a fire trench, keep it from being heated to the ignition point, as we do when we widen the trench or when we use water, or shut off the supply of oxygen as we do when we throw dirt, use water, or bury a burning log, and you can stop the spread of any fire. *Every one of our methods of fighting fire is based on one or more of those three simple essentials.* THERE ARE NO OTHER WAYS.

1. Fuel.—Chemically all of the fuels that carry our fires are practically alike. From grass and brush to tree needles, tree trunks, and rotton wood on the ground they are all of the type that the chemist designates as $(C_6H_{10}O_5)_y$. This means that there are 6 atoms of carbon, 10 atoms of hydrogen, and 5 of oxygen in each molecule of cellulose. Starch, which is found in the roots, seeds, and leaves of all plants is very similar, differing only in the subscript. The chemists designate the various starches as $(C_6H_{10}O_5)_x$.

This point is important to remember because it helps to reduce some errors of judgment based on the belief that the chemical nature of our fuels differs very materially. When $C_6H_{10}O_5$ burns every molecule of that substance combines with six molecules of oxygen. The resultant products are gases, 6 molecules of carbon dioxide, and 5 molecules of water vapor. Fire makes water out of the hydrogen and oxygen atoms that are in every molecule of wood. The chemist writes it this way: $C_6H_{10}O_5+6O_2 \rightarrow 6CO_2+5H_2O$. Unfortunately that water is not of any help to us because it exists as a gas, a superheated gas, which rises straight up and away from our fuels. The water that really counts is the moisture content of the grass, trees, or brush before they burn.

Because of this similarity of chemical composition of our fuels it is obvious that we should not calculate probabilities on the belief that different kinds of wood or brush or grass burn differently. The leaves of grass, trees, and brush, and the bark and wood of trees are all largely cellulose. The big variable which produces really significant differences in fire behavior is not the chemicals, it is the moisture content.

There are, however, two other ingredients in wood in addition to cellulose that are of some, perhaps academic, significance. One of these is lignin, a substance for which the chemists do not know the formula. The significance of lignin lies in the fact that it has a slightly higher heat content than cellulose and that it leaches and decays more slowly. Hence old wood is likely to have lost more cellulose than lignin and therefore will have a slightly higher heat content per pound of material remaining than fresh cut or freshly killed wood. Differences in the pitch content are also known to affect the heat of a fire.

There are also some other minor differences in the chemical nature of plant and tree leaves but a series of tests of the fat and oil content of the leaves of six different genera of weeds and brush which were made for three consecutive summers failed to reveal anything significant. Instead this chemical study made at our Priest River laboratory confirmed the finding that moisture content is THE big variable.

2. Ignition.—When there is plenty of fuel, the next essential of combustion is that it must be heated to the ignition point. For dry cellulose a temperature of only 400° to 600° F. is required. The average usually used is 540° F. The point that is of practical importance is that if your fuels are even moderately dry they do not have to be heated very hot to reach this ignition temperature. In other words the kindling temperature of grass, wood, cotton batten, or cellulose in any natural form is easily produced. It is not an abnormally high temperature. You will build more held line and have to charge up less line lost if you remember that simple fact and then do something about it.

The key to ignition is the ease with which a fuel can be heated to 540° F. That ease naturally depends upon one obvious difference in fuels, i. e., their size. The fine fuel naturally heats clear through and reaches 540° far quicker than a heavy fuel like a log. Size of fuel is therefore the significant feature to watch, other things such as moisture content being equal. Actually, size and moisture content influence the process of combustion in much the same way. Make a stick wetter and you reduce its ease of ignition. Similarly, the bigger the stick the harder it is to ignite it. The wet stick and the big stick both require more time or more heat to raise their surface temperature to the ignition point. And that is another good basic fact to keep in mind both in sizing up probable fire behavior and in deciding on tactics to use along the line. Let your fire burn through the heavier fuels where it will burn more slowly. Fight it at those places where it would go into finer fuels and spread faster. Also, fire line construction is easier in the fine fuels. You gain in two ways by using this basic knowledge.

Size of fuel is also worth noting from another angle. Take 10 pounds of dry grass or dead pine needles, 10 pounds of dry branchwood, and 10 pounds of log in one chunk and ignite each of them. What happens? The needles will liberate their B. t. u.'s (British thermal units) in a few seconds, the branches will release theirs in a few minutes, while the 10-pound log may take half an hour to release its heat. Ease of ignition is, therefore, not the only difference in fire behavior to expect in accordance with different sizes of fuel. The rate of release of the energy is also tremendously different.

This feature, combustion rate, is what a football player would call the triple threat of fire. And this rate of release of energy is the one feature we fail most often to recognize. The three threats involved are: (1) The more sudden the release of all this heat the farther it will radiate a temperature of more than 540°. And that means something to your tactics. It means that if the fuels are even moderately dry, a wider fire line is needed wherever you find an appreciable volume of fine fuels. This applies to both stopping a fire and in backfiring. (2) The faster the release of those B. t. u.'s the greater the volume of gas suddenly created, hence the faster it will rise overhead. That also means something to tactics employed, because the swifter the rise of hot air the greater the chance of sucking up blazing embers and carrying them up and over the line, if the smoke is leaning across the line. That means spot fires. (3) The faster this release of energy and the faster the uprush created by it the greater the local wind velocity created by the fire. Moderate to large areas of fuel releasing their energy suddenly are creating conditions that breed not only higher wind velocities but twisters or even big whirlwinds. I once saw one of the really big ones whirl like a tremendous barrel and move across 2 square miles while I was running 200 yards along the top of Desert Mountain, on the Flathead Forest.

3. Oxygen.—This last essential of combustion is one that we can't do very much about. Combustion engineers who design and operate boilers do a lot by controlling this one of the three essentials. But under our conditions there is almost always plenty of oxygen to facilitate combustion of our fuels. Under free burning conditions such as occur on a forest fire about 10 pounds or 133 cubic feet of air is needed for the complete combustion of only 1 pound of dry fuel.

The one time when we do something to reduce the oxygen supply is in throwing dirt. While that dirt does lower the temperature of the fuel it lands on, the principal function of dirt is to shut off or at least reduce the supply of oxygen. Moist dirt is superior to dry dirt primarily because it lowers the temperature more. But when either moist or dry soil covers the surface of the fuel the major benefit is by cutting down the oxygen supply. Water also does the same thing if enough is applied to form a film over the surface of the fuel. But here too the major benefit is in lowering the fuel temperature below the ignition point.

Combustion a Molecular Chain Reaction

The public has heard and read a lot recently about atomic fission, so controlled that it becomes a chain reaction and thereby makes possible atomic bombs. More understanding of the fire job and better financial support by the public may follow when we show that the job of fire control is definitely one of stopping a chain reaction which differs from the bombs primarily in that ours is a molecular instead of an atomic chain reaction.

A chain reaction may be compared to a chain letter; you receive one but you send out two or maybe three or four. Each of the recipients of one of these letters similarly sends out two or three or four. The thing spreads like wildfire. The first problem in producing an atomic bomb was along this line. That problem was to obtain certain chemicals which when assembled in a sufficient quantity and arrangement, known as the "critical mass," would perpetuate the process of splitting atoms of uranium into atoms of two other elements, barium and krypton. It was known as far back as 1939 that in this splitting tremendous energy was released and that the process then split other uranium atoms which in turn released more energy and split more atoms, the process continuing and accelerating as long as there was a supply of a suitable fuel in a proper arrangement and condition. The job of the atomic physicists was, therefore, to produce this chain reaction yet control it. Our job is simplier. It is merely to control the molecular chain reaction that is fire.

As you can see, fire is a similar process in that if you heat one molecule of a fuel to the ignition point its process of changing from $C_6H_{10}O_5$ into CO_2 and H_2O may release enough energy to ignite several other adjacent molecules of $C_6H_{10}O_5$. If the fuel is in a critical condition (dry enough), as compared to a critical mass (large enough), that process then becomes a chain reaction and not only spreads like wildfire but it really is wildfire in our case. Whereas the nuclear physicists have to make their fuels, and arrange them carefully in an atomic pile, our fuels are arranged for us and then, periodically, are put into proper condition (dryness) such that the chain reaction starts whenever and wherever the spark is applied.

If this sounds farfetched or academic let me call your attention to one more fact, which I know you will not dispute. It is this: That when our fuels are in their most critical condition, i. e., their driest, we have some molecular chain reactions which are so violent that we *cannot* stop them, just as there is no stopping an atomic bomb once its chain reaction is started. Furthermore, we have occasions when combustion in the form of a forest fire approaches a rate and even a

magnitude rivaling an atomic bomb. Those of you who were on any of our big fires in 1929, 1931, and 1934 probably saw some of these explosions. Many of them covered several square miles in only a minute or two.

If you will keep this chain reaction idea in mind, and if you will size up your fire, either as a whole or on your sector, in the light of the three basic essentials of combustion you may be able to calculate the probability of one of these explosions. If you can do that you may be able to save your own life and the lives of your men, as well as improve your fire control tactics.

There is one basic criterion to watch, however, in trying to anticipate a molecular chain reaction at an explosive rate. This is moisture content of the fuel, for it is moisture content not mass, nor volume, nor size, nor arrangement of fuel which *first* determines whether or not a forest fire can truly explode. And you should remember that this moisture content not only can be but is being measured. You can get these measurements every day if you want them.

MOISTURE CONTENT THE CRITICAL VARIABLE

We have not had any true forest fire explosions in Region 1 since 1936. I believe there were a couple of minor ones that year on the Little Rockies Fire on the Lewis and Clark Forest. But we had several really big ones in 1934, 1931, 1929, one or two in 1926. You have all read about those in 1919 and 1910. The main reason why we have not had any explosions in recent years is this matter of moisture content. Our fuels simply have not dried out to the critical condition that developed in those earlier critical years. Hence, it is evident that the critical variable in fire behavior is moisture content of the fuels. Consequently I want to call your attention to some of the possibilities available to you for improving your calculation of probabilities by watching fuel moisture above all other elements.

Basis of Fuel Moisture Measurements

You all know about the fuel moisture indicator sticks used at some 175 fire danger stations in Region 1. There are some things those sticks will tell you far better, far more accurately than you can estimate. To make best use of those stick measurements you need to know: Why we use half-inch sticks, how they are made, and how accurate they are.

For four consecutive summers, 1922, 1923, 1924, and 1925, I collected at periodic intervals samples of the the five major dead fuels that burn in a forest fire. I took these samples to the laboratory and determined their moisture contents. I found out which fluctuated the most, and which the least. On this basis I selected the top layer of duff, half-inch sticks, and 2-inch-diameter branchwood as the best representations. We therefore used duff hygrometers, half-inch sticks, and 2-inch sticks at several fire danger stations for the next 5 years to measure fuel moisture. Then at the suggestion of the rangers in a regional meeting and despite my protest, we discontinued used of the 2-inch ones. Finally in 1942, with the Model 6 Danger Meter, we dropped duff moisture and began to rely solely on the half-inch sticks.

From a technical viewpoint these half-inch sticks alone fail to represent our fuels in two ways: (1) They do not show the true benefits of light rains as well as duff moisture measurements did; (2) after heavy rains they dry out faster than either duff or 2-inch-diameter sticks. The error is therefore always toward showing more danger than would be revealed if all of the significant *forest* fuels were measured. The half-inch sticks are not too fast, of course, for cheatgrass, but this fuel type does not cover a large percentage of our area. Furthermore, after it has cured, cheatgrass responds so closely to changes of relative humidity that humidity measurements can very well be used as an index of moisture content of that one fuel type. Finally, cheatgrass changes moisture and flammability so rapidly that you might as well always be ready for the worst.

The half-inch sticks which we now use are made from new lumber each year. Any one of several species of wood could be used, because here again we are dealing primarily with cellulose. We use ponderosa pine because it is readily obtainable in clear stock at a reasonable price. We use only sapwood because it is the moisture content of sapwood of twigs, branches, logs, and snags in which we are most interested. We can ignore the moisture content of the heartwood of a log because if the outer sapwood is extremely dry the inner heartwood has got to be dry too. We also ignore the effect that bark has on natural wood because if we used natural sticks with bark on them some of that bark would soon chip off and then we would no longer know the true oven-dry weight of our sticks.

To be sure that moisture measurements made at different stations do not differ because of differences between the sticks or because of errors by the danger station operator, we go to a lot of work and incur considerable expense. These sticks now cost from $1 to $1.75 per set to manufacture. In making them they are oven-dried and then cut off at the ends until they weigh exactly 100.0 grams *oven dry*. This is done so that all that is needed to determine their moisture content in percent is to weigh them and subtract 100.0 from the total weight.

As you can see, this difference in weight is not only the weight of the water in the wood, picked up from the air and from rain, but it is also the moisture content expressed as a percentage of the oven-dry weight. Consequently, when you call for a fuel moisture content measurement from any of our stations you can bank on its accuracy probably 95 times out of 100. The other 5 times the scales will be out of balance, which is an operator error, or the operator will have read the scales wrong. Eliminating that error is a job for training and supervision.

Application of Stick Moisture

By the present practice we measure stick moistures at only two to four occupied stations per ranger district. That is not enough under some conditions of spotted weather, wet here and dry there, but under widespread and long continued drouth it is fully adequate. The sticks are exposed on a flat, in the open, but under a shading layer of screen cloth. The reason for this, preparing to meet "average-bad" conditions, is used in all fire control planning in Region 1. The sticks are therefore always exposed alike at all stations so that the results are truly comparable.

The intention in such an exposure is to sample average-bad but not the very worst conditions. By sampling average-bad conditions we are using the sound engineering principle of preparing for the worst probable but not the worst possible. Engineers did not build the Golden Gate Bridge at San Francisco to withstand the worst possible earthquake. They built it to withstand the worst probable. Few ditches, storm sewers, or bridges are built to withstand the worst possible flood. To meet worst possible conditions usually costs more than the resource is worth. It is better economics therefore to accept the risk of the worst possible flood, earthquake, or fire weather conditions, and plan to meet only the average-bad or worst probable. We can get adequate fire control at a justifiable cost by using this principle. We do use it, not only in fire danger measurement, but also in all phases of fire control planning in Region 1.

The double layer of 12-mesh screen cloth under which we expose our sticks provides an amount of shade and a fuel-moisture equivalent to what you would get if you operated two danger stations, one in full sun and one under the half shade left after a moderately heavy logging operation. The stick moistures obtained by this method can therefore be accepted as representing average-bad conditions. Open south slopes will have drier half-inch sticks. Densely timbered north slopes will have materially higher fuel moistures. But when the sticks at our stations have high moisture contents, adjacent areas, both open and timbered, also can be expected to be moist to wet. When our sticks are each day showing lower and lower moistures you can depend on it that both the open areas and the timbered slopes will also be getting drier and drier.

Our present sticks and exposures therefore give you one definite and dependable index to watch. They give you something that you can use in calculating, instead of guessing.

The most significant single feature of stick moistures to watch for is just this: Are they below 5 percent and how long have they been there? Your danger of blow-ups and explosions can be really calculated by getting merely that information. If the sticks at both the nearest ranger station and some nearby lookout have been down below 5 percent for several days you can bank on it that every fuel type in that area is in a truly critical condition. Fortunately this does not happen very often, but it has happened and it will happen again. When it does you will be making the mistake of your life if you fail to know it. You can always find out by consulting the local ranger station fire danger charts or Form 120 R–1. If you are already out on a fire a phone call will bring you the desired information.

If the sticks are reported as at less than 5 percent you should then ask for two more things: a check of the computations to be sure no errors were made, and a remeasurement of the sticks right then. The dispatcher or his assistant can do both of these in 10 or 15 minutes. If these checks verify the original reports you can then *calculate* that every fuel type in the area, on both north and south slopes, and at all altitudes, is in its most explosive condition. You can bank on it that fire will spread in all of these types at the fastest rate, that there will be little difference in rate of spread between fuel types, and that the danger of both spotting and of big whirls will be at a maximum. You can expect a chain reaction at its worst.

Those of you who have never seen fires like the Lost Johnny and Half Moon on the Flathead in 1929, the Freeman Lake on the Kaniksu and the McPherson on the Coeur d'Alene in 1931, and the Pete King on the Selway in 1934, simply cannot fully appreciate the significance and the danger under these conditions. It may be enough to point out that the Freeman Lake Fire, starting at 10:30 a. m. on August 3, 1931, exploded almost from the start to cover 20,000 acres in the next 12½ hours. This is at the rate of 1,600 acres per hour, from a standing start! Both duff and 2-inch-diameter sticks were down to 4 percent moisture content that afternoon. Wind was 13 miles per hour at 10 a. m., and 18 miles per hour at 7 to 8 p. m. Relative humidity was 10 percent or lower from 2 till after 7 p. m. THAT is explosive fire weather.

Differences in rate of spread between fuel types practically disappear under these explosive conditions. The basic laws of chemistry take charge when nature produces such conditions and the molecular chain reaction is actually unstoppable until the wind goes down, the humidity goes up, and the fuels absorb a little moisture. If you have to fight such fires, and you should be mentally ready for it, you will probably do it like Kelley and Ryan fought the Freeman Lake explosion. You will not build much fire line that day, but you will calculate where that fire front will be at midnight and you will then have fire camps and men well distributed around it and ready to begin work at the first crack of dawn. Kelley and Ryan had more than 600 men strung around the Freeman Lake Fire front the next morning after that fire started, and those men never let that fire make another major run. That is a record to shoot for; it has seldom if ever been equalled in this region.

The real difficulties and the most frequent need of skill and understanding by fire bosses come, however, in judging gradations between this explosive condition and that easiest of all conditions when fire will spread, but only so slowly that control is largely a problem of how to do it at the least cost. In between this explosive condition and the easiest condition other factors than stick moisture become more and more important and all the factors become much more involved. It should be evident, nevertheless, that fuel moisture is THE major variable and that if you are to calculate accurately, your first and best bet is to get the stick moistures and other measurements from the nearest danger stations *before* you even start to order men. After you get to the fire you can then see to it that you are informed each day, preferably twice a day, as to how fuel moisture and other factors are changing. There are then three other major variables to watch. These are fuel type, the thermal belt, and wind.

FUEL TYPES

Some men have a misconception about fuel types because they do not understand that our four rates of spread—Extreme, High, Medium, and Low—represent differences only on a class 65 to class 75 day. Obviously, rate of spread will not differ at all in different types when the woods are soaking wet. Also, rate of spread is very nearly the same in all types after several August days with the temperature

at 100°, humidity at 10 or 15 percent, and the afternoon wind at 15 to 20 miles per hour. Hence, we have used the principle of preparing for the average-bad in our fuel type classification, and the rates given on our fuel type maps are those to be expected on an average-bad day. This is about class 70 on our burning index meter. You cannot use those fuel type maps correctly, or dependably, on any other basis.

Our fuel type classes are therefore based on differences in rate of spread, not at the explosive point where we can do nothing about it, but at combinations of moisture contents, wind velocity, and vegetative conditions just short of the explosive point. These begin early in August whenever fuel moisture drops to 5 or 6 percent, the humidity falls to less than 15 or 20 percent, and the wind rises above its normal afternoon average of 6 or 8 miles per hour. After several days of such weather, especially if the burning index rises to 75, as it will with fuels under 5 percent, humidity under 10 pereent, and winds of more than 10 miles per hour, differences in rate of spread become less and less as all fuel tyes approach the explosive condition.

A burning index rating is therefore essential to calculation of the probabilities in any fuel type. If it shows class 65 to 75 you can count on the differences shown by the fuel type map, insofar as that map is well made. The weaknesses in these maps are well recognized and steps are being taken to correct them.

In applying the burning index to a correct fuel type map some guides have been worked out, but this is unfortunately a field in which our fire reseach has been woefully weak. Our best contribution is in U. S. D. A. Circular 591, Influences of Altitude and Aspect on Daily Variations in Factors of Fire Danger, by Lloyd Hayes, published in 1941. The outstanding new fact resulting from this research was the discovery and general location of what Hayes called the thermal belt.

THERMAL BELT

The major significance of this thermal belt is that inside a certain altitudinal zone burning conditions change less from daytime to nighttime than they do in either the valley bottoms or on the mountain tops. At Priest River this zone begins about 600 feet above the valley bottom and continues upward for about 1,000 feet. Below and above this zone fuels pick up more moisture at night than they do within it. Within the zone the fuels lose a little every afternoon and pick up a few percent between 6 p. m. and 3 a. m., but the change is very slight. Up on the mountain top, however, the same fuels will pick up 4 percent more at night and lose 4 percent more in the daytime. Down in the valley bottom they will pick up and lose 8 to 12 percent more than within the thermal belt. This is true on both north and south aspects. The only places where it may not hold true are in steep-sided, deep, east and west canyons like that of the Salmon River. In that canyon and perhaps in a few other spots like it, the depth of the canyon and its orientation in relation to prevailing winds combine to interfere with normal air drainage. There the thermal belt effect becomes less pronounced or even disappears. Sometimes going fires will also disrupt this belt, if the fires are large enough, but in most places and under most conditions you should calculate your probabilities on

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the basis of the known difference of burning conditions within this thermal belt.

The next time you have a fire starting in late afternoon or early evening about 1,000 feet up from the main valley bottom, I suggest that you note for yourselves whether or not that particular fire does not run faster and for more hours during the night than a similar fire in the valley bottom. Also note whether or not that fire picks up and starts to run earlier in the morning. I think you will find both of these conditions in almost all thermal belt fires. They are essential elements in the equation required to calculate the probabilities.

These facts also should be highly significant to all fire dispatchers. Other things being equal, more men should be sent, and they should be speeded on their way faster to every fire in the thermal belt. Furthermore, on a going fire, if night work can be done on any sector, it should be planned first on those portions of the front from 500 feet to 2,000 feet above the valley bottom, because this is the zone of the thermal belt. Within this zone you can expect the least benefit from increased fuel moisture at night.

WIND

Although fuel moisture is the critical variable that puts all fuel types in an explosive condition, or reduces them to an easy job of fire control, wind velocity is often the straw that breaks the camel's back. In fact at fuel moistures of 6 or 7 percent up to 20 or 25 percent, wind is often the variable which finally determines what a fire will do. Some basic research by Fons at the California station has shown that with fuel moisture at 8 percent variations of wind velocity are more significant in changing the rate of spread than are variations in fuel temperature, fuel size, compactness, or density.

Whether or not some fire seasons are, as a whole, windier than others I do not know. But we do know that wind is a result of certain meteorological conditions which change periodically at from 3- to 5- or 6-day intervals. If you will watch the wind record portion of any fire danger station chart, particularly for a lookout station, you will see a gradual increase of wind for several days, then a decrease, then another increase. Obviously, by watching this up and down trend you can definitely improve your calculation of the probabilities, even though you cannot forecast precisely.

There are a few general rules of wind behavior which can be used locally in Region 1. First, is a discovery, made by Hayes and described in Circular 591, that the places of greatest wind danger at night are, strange as it may seem, the north aspects at high altitudes. To put it another way: While you can usually count on the wind dying down during the night in the valley bottom, you should not count on this if your fire is up on the high divides between major drainages. Instead, at the higher elevations you should expect the highest winds at night, not in the daytime, and more wind on the north aspects than on the south.

Another general law of wind behavior during the ordinary fair weather of June, July, and August, that is quite well known, is that during the day the wind usually blows up the canyon or creek, while

during the night it blows down canyon. This reversal of direction in the evening usually takes place just a few minutes after sundown. When both the daytime and the night winds are very light—less than 4 miles per hour—this reversal may not be of much significance. However, in topography and on areas which are materially heated by the sun's rays, the afternoon wind created by rising hot air may amount to 8 or 10 miles per hour. When this is the case reversals at sundown may produce a significant down-canyon wind. This condition is most pronounced on south aspects and in watersheds draining toward the south into a big canyon running east and west, like that of the Salmon River. But even under these conditions a large fire may create such an updraft as to upset the normal reversal of wind. Hence, while this generality is worth considering in your calculations there are other factors which also must be recognized before you make your final estimate of rate of spread.

From what has been said it should be clearly evident that "calculating the probabilities" means doing much, very much *more* than just fight a fire with brute strength and numbers of men. It means careful consideration of every available source of information concerning each of the basic factors of fire behavior. But even when that has been done you will still have to use judgment, and perhaps even do some pure guessing. Nevertheless, your batting average is absolutely certain to increase IF you first do the best you can to calculate on the basis of facts and known principles.

EXPERIENCED JUDGMENT

Perhaps I should not close on this point, because if by doing that I cause you to discount *any* of the things previously called to your attention then I weaken my point. However, in fire control there are still a lot of basic factors not yet understood or not yet measured. And even when they are measured the basic facts must still be put together, weighed one against another, and a balanced decision then reached. Worse yet, sometimes that decision must then be modified or even seriously compromised on the basis of what you *can* do about it.

Experienced judgment is therefore the final determinant of what you actually do, both in planning to control a fire and out on the fire line where you try to put your plan into effect. But if you will stop to examine just what is meant by experienced judgment you will come back to the items I have listed above. For what is experienced judgment except opinion based on knowledge acquired by experience? If you have fought forest fires in every different fuel type, under all possible different kinds of weather, and if you have remembered exactly what happened in each of these combinations of conditions, your experienced judgment is probably very good. But if you have *not* fought all sizes of fires in all kinds of fuel types under all kinds of weather then your experience does not include knowledge of all the conditions. In that case some of the facts and principles described above should be helpful to you.

SUMMARY

There are only three things you can do to stop a fire—rob it of its fuel, keep it from being heated to the ignition point, or shut off the oxygen supply.

When it comes to fire behavior there are likewise only a few basic variables. The big one is fuel moisture and when our fuel moisture indicator sticks are below 5 percent you can expect your fires to blow up and explode. As that moisture content rises above 5 percent your fires become less and less explosive and you know that they are then more and more influenced by another major variable, wind.

Both fuel moisture and wind are measured every day of the fire season at numerous stations. Those measurements will show you clearly and accurately what the present moistures and velocities are, and how they are changing, whether getting better or worse. These are facts. They are available to you. They were not available to the rangers and supervisors who fought the fires of 1910 and 1919, nor to many men in 1928 and 1929. You therefore have this accurate knowledge that those men did not have.

Furthermore, you have some knowledge of how both fuel moisture and wind velocity differ according to altitude and aspect. The outstanding general differences are known. Very few if any of the most experienced old-time fire fighters knew these things.

And finally you have not only excellent topographic maps to help you visualize your fire area, but you have the major differences in fuel types shown clearly so that you can calculate what you should expect your fire to do on this particular slope in the next few hours.

It is true that you still have to estimate how much different the fuel moisture will be at your fire from what it is at the fire danger station. You also may still have to guess what the exact wind direction and velocity will be on your fire even after you find out what they are at the nearest ranger and lookout station. And it is true that there may be an acre of High-High fuel right near your fire even though the map shows Medium-Medium or even Low-Low. But if you have been on your district very many years and have gotten around, or if you have someone else there who really knows his fuels, you may be able to pick up that important fact.

CONCLUSION

Even though there are some holes in our information, we have much more than our predecessors. Those men had to think of EVERYTHING. They even had to go to town to buy their axes and shovels and grub. Then they had to remember out of their own personal experiences what the topography and timber and brush types were like, up there at the fire. Finally, they could only feel the wind and kick the duff to see how dry the fuels were, right where they stood. Finally they could look at the sky and guess at what the weather might be tomorrow. May be some of them prayed.

But times have changed. Where those old timers had to guess at most everything, today, we have measurements and maps and many other facilities. While we might like to have more, I doubt that anyone ever will be able to sit down to a machine, punch a key for every factor of the situation, and have the machine tell him what to do. Fire control still requires headwork based on knowledge. If we will make a purposeful attempt to use all of the knowledge and all of the facilities that are available to us today we can do one thing the old-timers could not do: We can come mighty close to getting adequate fire control, and at an operating cost far below what it used to be.

SAFE STORAGE OF FIRE TOOLS

R. W. Bower

Fire Control Officer, Modoc National Forest

The Modoc National Forest has two problems in connection with warehouse storage of fire tools. Warehouse space was limited and the method of storage needed to be safe. The ordinary overhead type of rack for shovels and McLeods was dangerous because of possibility of tools falling out of racks. The type of rack for axes that allows the ax to hang by the head is also dangerous because of chance of a person striking an exposed blade.

The tool rack shown in the photo solved both these problems. It is a very compact arrangement with maximum use of available space. It is a very safe arrangement because there is no overhead storage and it is always necessary to reach for the handle of each tool instead of the head or blade. There have been no accidents from handling loose tools in the warehouse since this system was installed.

AN EFFICIENT SNAG PUSHER

R. W. Bower

Fire Control Officer, Modoc National Forest

One of the greatest fire hazards in the Northeastern California pine timber type is the presence of numerous snags due to past depredations of the pine beetle.

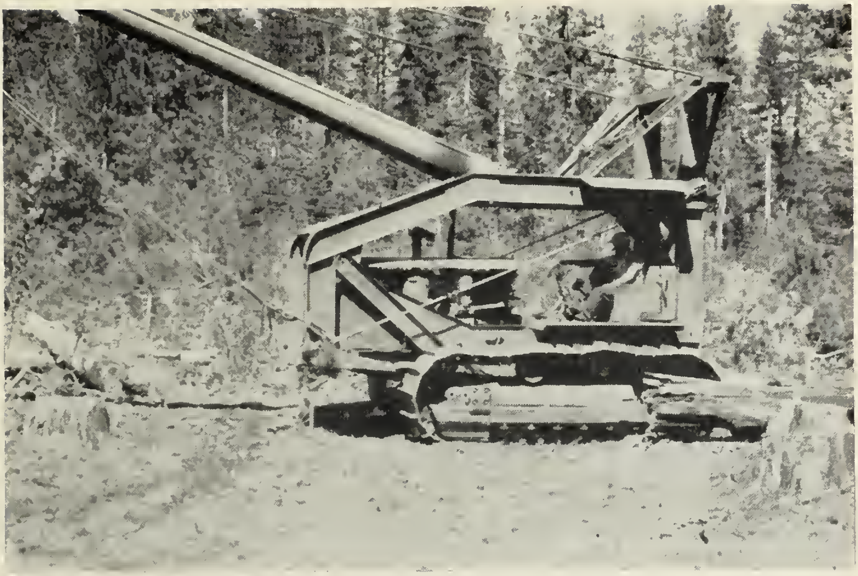
An analysis of all the class C, D, and E fires on the Modoc National Forest for a 5-year period showed that of all the fires starting in timber type, 70 percent were lost by the initial attack suppression crew because of snags throwing more spot fires than the crew could handle. The standing snags are far more dangerous than slash on the ground.

Snag pusher with boom against snag.

For this reason, any fire hazard reduction program must place snag disposal high in priority.

The Finney Logging Co., operating on lands of the Red River Lumber Co., within the Modoc National Forest boundary, has adopted the 100 percent snag falling alternative under the slash disposal requirements of the California State Forest Practice Act. Mr. Ted Finney, manager, has built a snag pusher in order to do the snag-disposal job economically and rapidly.

The main feature of this snag pusher is the 30-foot steel boom connected to a heavy channel iron frame and mounted on a D8 Caterpillar tractor as shown in the photo. Mr. Finney made the frame exceptionally heavy in order to afford maximum safety to the operator. It will stand the full weight of a falling snag if one should break back over the boom.



Arrangement of boom and frame on tractor.

This rig will push well over 300 snags per shift in heavy stands and will average about 200 snags per shift in average stand conditions of about 2½ snags per acre.

The crew consists of an operator and swamper. The swamper tallies the number of snags pushed daily as well as scouts out best route for travel of rig from snag to snag.

Fire Fighting De Luxe.—Region 3 hates to see Region 1 dropping all that water from B–29's so we felt we should go them one better.

A letter has just been received from the Range Developing Co., Phoenix, Ariz., which says among other things:

"It might be interesting to you to know that on Friday afternoon, September 5, the writer discovered a small fire burning in the Prescott National Forest just east of Walker. While bringing about rainfall over the municipal drainage area of the city of Prescott, a thunderhead formed directly above this burning area. I flew into the thunderhead at about 5:15 p. m., dropping approximately 80 pounds of dry ice pellets which brought about an immediate heavy downpour. On circling the area about 6:30 p. m., there was no evidence of fire left. We have no reason to doubt this fire was definitely put out through our efforts alone."

On the same day Assistant Ranger Bill Anderson reports:

"Another man and I went to a small fire east of Walker. We had just got the snags felled when we observed a large cloud which we hoped might bring rain and heard a plane overhead. And in a few minutes, boy! did it ever rain—and hail. We got awful wet but it sure did put that fire out quick and saved mop-up."

The Region's position is obvious. We are certainly going to be much interested in every cumulus cloud—particularly next May and June—and are now considering the addition of raincoats to all our fire caches. No fooling!

Seriously, the Range Development Co. has offered free demonstrations and the region will take full advantage of the offer.—DON BECK, *Region 3, U. S. Forest Service.*

MAKING CONTACTS AND ESTABLISHING GOOD WILL

C. H. Coulter

State Forester, Florida Forest Service

In Florida 99 percent of our fires are man-caused, about 72 percent being deliberately set. This adds up to a tremendous human relations problem—the job of selling fire protection to an indifferent and often antagonistic public.

With this in mind, "Making Contacts and Establishing Good Will" was prepared. It was read, discussed, and taught at our fire control training schools. It is for towermen, assistant rangers, rangers, and others to use in properly approaching the public—the first step in getting their cooperation.

ATTITUDE OF PERSONNEL

In order to successfully sell the program of the Florida Forest Service to individuals and the public in general, it first becomes necessary for the individual employee to believe whole-heartedly in the purposes of the organization and the people in it. In other words, he must first sell himself on the idea that his organization is a good one, and that he has something to offer the public.

From time immemorial it has been proved that nothing is so contagious and stimulating to morale as individual and collective pride. If you thoroughly believe in, and are enthusiastic about your organization, you will soon transfer this enthusiasm to those you come in contact with.

By the same token, nothing will spread so quickly and cause as much discontent and corruption in an organization as a dissatisfied employee—for example, the individual who hangs on merely for the purpose of drawing his pay check, and who is constantly knocking and grumbling about the organization and those in it.

All of us will profit by recalling Elbert Hubbard's adage on loyalty: "If you work for a man, in heaven's name, work for him! . . .—speak well of him, . . . and stand by the institution he represents . . . an ounce of loyalty is worth a pound of cleverness.

"If you must vilify, condemn and eternally disparage, why, resign your position, and when you are outside, damn to your heart's content. But, I pray you, so long as you are a part of an institution, do not condemn it. Not that you will injure the institution—not that—but when you disparage the concern of which you are a part, you disparage yourself.

"More than that, you are loosening the tendrils that hold you to the institution, and the first high wind that comes along, you will be uprooted and blown away . . .—and probably you will never know why."

We are often too prone to speak of, or demand, our constitutional rights, or to say that we are entitled to private opinion. For your information, the following excerpt is quoted from A Pocketful of Pebbles, by Jan Struther:

> Private opinion creates public opinion. Public opinion overflows eventually into national behavior, and national behavior, as things are arranged at present, can make or mar the world. That is why private opinion, and private behavior, and private conversation are so terrifyingly important.[1]

A careful analysis of the above will be of great benefit to all of us and will at the same time not deprive us of our private opinions so long as they *are* private opinions and not used as a subterfuge to stress our point and do harm to an individual or organization.

In our everyday work we must put aside our individual ideas and work for the good of the Service. REMEMBER—what is good for the Service is good for you.

If a particular deed is worthy of praise, it should be looked upon in the light of "WE;" by saying that "WE" accomplished this particular deed the entire organization will receive credit for its accomplishment. After all, we should strive to work together as one big organization, or team, instead of as individuals. Be careful not to develop the "I" complex.

Superiors should be quick to notice and offer praise for outstanding work. Experience has taught us that every person and group of persons will react to kind words and encouragement if properly given out in deserving cases.

PERSONAL APPEARANCE

Much of the success obtained in meeting the public will depend upon your personal appearance. It is not necessary that you be a "white collar dude" or that you appear in formal dress. Just remember to do the best with what you have. No one likes to hold a conversation with a ragged and unclean person. It has often been said that "Cleanliness is next to Godliness."

The occasion may arise when out of necessity you will be forced to talk with persons or strangers immediately after fighting a bad fire or doing a dirty job. Your appearance on this occasion may be explained, and the person you are talking with will understand the circumstances and make allowances for it. He will not, however, overlook your dirty appearance if you are in that state every time he meets you.

Some persons will judge you by the condition of your equipment. Keep your truck and other equipment as neat and clean as possible. REMEMBER—every citizen of the State of Florida has helped to pay for your equipment, and there will be certain persons who will try to find fault with it. Give them no cause for criticism.

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[1] Printed with permission of Harcourt, Brace and Company and Reader's Digest.

MEETING THE PUBLIC

The Approach

There is only one way to meet and greet the Public—the RIGHT way. The RIGHT way will, of course, depend largely upon circumstances and the persons involved.

Meeting the person you know.—If you know this person's name be sure to call him by it. Experience has proved that every person likes the sound of his own name; he has had it since birth, and it is his oldest possession. His name seems to fall softly on his eardrums and leave him with the satisfied feeling that he has at least made an impression strong enough to cause you to remember who he is.

If you do not recall his name, don't try to bluff your way for he will soon learn that you are bluffing and will probably resent it. If you cannot remember his name and yet recall the occasion of your last meeting, then refer to this meeting and ask him his name. When he tells you his name, repeat it several times to yourself, and if possible associate it with some event or other thing which will enable you to easily recall it next time.

Refrain from addressing a person as "Brother." The individual you are addressing may not like you and would not want to be your brother, and in any case, the term sounds insincere and artificial. Nicknames should be used only where you know the individual well enough to take this privilege.

Meeting the stranger.—Remember, first impressions are sometimes lasting. You may be judged by your initial conversation or behavior, and if it creates an unfavorable impression, you may never be able to convince your listener that you were not acting in your normal and usual manner. Also bear in mind that you represent the Florida Forest Service and the State of Florida. You are their ambassador; make them proud of you and endeavor to make the public respect you.

The introduction.—Under all circumstances make your introduction as amiable and firm as possible. Approach the stranger in a businesslike but friendly manner, tell him your name and title, and make certain that he understands who you are. If you doubt that he clearly understands you, then take a few minutes to explain your duties or mission. After you are sure that he understands, start your conversation.

The Conversation

Your conversation will depend, of course, upon the circumstances at hand. If the person is already known to you, this should not be hard. If, on the other hand, the person is a stranger, make reference to his present activities after you have completed the introduction. Try to learn what the person is interested in and converse with him along these lines if you can intelligently do so.

If you are able to get the person talking about something he is interested in, you can later steer the conversation into other channels and probably learn what you want to know. Never dominate the conversation. If he should ask you questions, answer them in a truthful and understandable manner. Don't try to be sly or evasive.

If he should ask you questions which you cannot answer because of your lack of knowledge on the subject, don't try to bluff or guess your way through, tell him you don't know, and he will respect you for it. Wherever possible, tell him who may be likely to have the desired information. If you later learn of information that he wants, go back to him, if possible, and tell him about it. Don't make promises, however, that you can't keep. Always try to leave the person in a satisfied and happy frame of mind. If he should later find that you have given him a false answer, or have been bluffing, he will resent it and will probably judge your entire organization accordingly. You can learn more from listening than telling, and a few well-directed questions may get the other fellow started.

Profane and obscene language.—Many of us are prone to overindulge in the old American custom of swearing. We must be on guard at all times in an effort to eliminate this laxity. There are persons who strongly object to the use of profane and obscene language and are easily offended when it is used in their preseence. Certainly, everyone objects to its use if they are angry, or if the circumstances are such that they are at a disadvantage. Never direct this sort of language at persons, for nothing is proved or gained by its use, and it only tends to brand you as a foul-mouthed person.

Boisterous language.—A boisterous or loud-mouthed and noisy person is thoroughly disliked by everyone; and so is a braggart. In our enthusiasm over a particular subject, it is often easy to fall within this class. Be on the alert, and you will not be guilty of this practice.

Timidity and shyness.—This may on occasions be just as dangerous and damaging as too much conversation. Some persons have a reserve or "outer shell" which is often mistaken for timidity or shyness, but if you are one of these persons, try to overcome it. Avoid being a shrinking violet. Modesty is a virtue but can sometimes be carried to extreme. Don't try to be the "silent type." Don't be reluctant to engage in general conversations, especially if this conversation interests and includes you.

Accusations.—A person will dislike you if you accuse him indirectly of committing an offense. This is sometimes true where the person is directly accused, but at least it gives him a chance to defend himself. If you know of, or have reason to believe that a person is guilty of committing an offense, the wisest method would be to discuss the matter with that person and not with every Tom, Dick, and Harry on the highways and byways. The latter procedure will only serve to make him alert and enable him to build an alibi.

Even if you are certain that a person has committed an offense, discussing it with every person you meet will be of no value and will certainly not strengthen your case or cause in the final analysis. If your facts or evidence are true and complete, take disciplinary or legal action, whichever the case calls for. Don't be a gossip.

Keeping your temper.—Under no circumstances should you lose your temper; nothing can be gained in so doing. And always remember that a person who loses his temper is at the mercy of a cool opponent. There will be occasions when persons will deliberately try to "get your goat," or make you mad. Don't be a victim of this.

Arguments.—For every argument won there must be a loser. A prolonged discussion of differences in opinion will eventually lead to

heated argument and usually proves nothing. Always remember that every person is entitled to his own opinion. You need not try to convince all others that only you are right. There are two sides, and sometimes more, to every story.

It is natural for persons to have different opinions. If a person's opinion or viewpoint is different from yours, you will seldom win him over to your side through argument. If you differ in opinion, never tell him bluntly that he is wrong. Merely tell him that he may be right, that in your opinion you see it thus and so. Remember, you are representing the State of Florida, and it will be for the best interest of all concerned if an argument is avoided. If for some reason you must show him that he is wrong, then it will be best to do so in a way that will allow him to feel he was at least partly right and thus save face.

Flattery.—Never stoop to flattery. Deserving persons will not expect it and others are not entitled to it. Certainly those persons who have accomplished some outstanding feat or act should be commended, but this does not mean they are to be flattered. It has often been said that flattery is a poor substitute for proper and deserving praise.

Don't be a "Yes Man." This type of individual is repulsive to the majority. Be firm in your convictions, without argument, and it will be a great help in making others like and respect you.

Admission of error or fault.—Man is not perfect. He makes mistakes easily and often. Nothing is so difficult for some persons as to admit they were at fault. If you have made an error, or are at fault for any reason, be quick to admit it to the person or persons concerned. Don't be dramatic about it. Others will respect you if you pocket your pride and admit that you have erred.

If you are never hasty in making decisions or statements where they are not needed, there will be little likelihood that it will be necessary for you to admit error. A good rule to remember is, "Do not make unnecessary statements or decisions and it will not be necessary for you to retract them later." In this manner you will demand respect from others, and they will be more likely to believe the things you do say.

THE DEPARTURE

Persons will remember you favorably and will extend a more genuine welcome on your next meeting if you have left them in a pleasant and happy mood.

Many of us are prone to use slang or pet farewells, such as "See you in church," or "Don't take any wooden nickels." These may, or may not, be out of order, but they have no particular meaning. Wherever possible, try to give a farewell which will have a meaning, will linger with the person, and will cause him to remember you pleasantly. Make your farewell sincere and sensible, such as "Hope to see you soon," or just plain "Goodby."

MAINTAINING CONTACTS

So many of us are prone to take our friends and contacts for granted. As a result, these friends feel they are neglected unless we want to get something from them. This feeling often causes a rift in friendships; it is not helpful to goodwill and will not strengthen our cause.

Whenever you can find the time, renew your contacts and acquaintances both old and new. Drop in on them occasionally and spend a little time in pleasant and interesting conversation. Never appear to be in a hurry. Sometimes a hurried contact or visit may do more harm to your cause than no contact or visit at all. But, don't be a nuisance and wear your welcome out. Don't give others the impression you have nothing to do.

One of America's political greats once said that he maintained a book with the names of all his voters; that this book contained information on his voters and their families, and wherever possible the names of their friends, relatives, and families. The politician stated that he studied this book carefully before each visit and tried to call members of the family by name, or to make reference to some incident which was pleasant to their memories. According to the politician, the results obtained were amazing and satisfying.

We cannot hope to set up a similar bookkeeping system for each of you, or to tell you how or when to call on your contacts, but at least the politician's procedure should help form a pattern for all of us.

Magnesium Wedges for Felling and Bucking.—The new magnesium wedges now on the market weigh only about one-fifth that of steel wedges of the same size and only slightly more than hardwood wedges. They combine the durability of the former with the lightness of the latter; thus, they should be superior to both as a fire tool wherever weight and dependability are factors.

We have subjected them to a trial of physical tests to determine whether this premise is correct.

Using a 1-pound magnesium wedge, which compares in size to the 12-ounce hardwood wedge and the 5-pound steel wedge (10-inch length), we found it adequate for normal bucking and felling use. In fact, it withstood hammer blows that quickly shattered wooden wedges. With severe abuse, the magnesium wedge can be distorted or shattered more readily than steel, but this abuse was far greater than what should occur on the job. We could produce no "mushrooming," but the magnesium did chip with repeated, deliberate, glancing blows. From a safety standpoint, however, we judged the extremely light metal to be relatively harmless as compared to flying steel. It was our conclusion that, with proper use, the magnesium wedge should have a lengthy life. We believe it to be the tool to use on any bucking or felling job where there is any degree of packing to be done.

Magnesium wedges are now available in a variety of bucking, felling, and power-saw patterns. At present prices they are about 10 percent more than steel and about three times the cost of hardwood wedges.—Walter J. Puhn, *Forester, San Bernardino National Forest.*

Rust Prevention for Milk Cans.—In using the 10-gallon tinned milk cans to transport and store water for fire camp use, it is necessary to keep them clean and dry at all times, especially when they are stored for future use. Any moisture, even that moisture resulting from condensation caused by changes in air temperature, will cause the cans to rust.

If a piece of zinc about 2 inches square is soldered on the inside of the bottom of these cans, rust on the bottom of the cans will be eliminated. However, no liquid containing an acid can be put in the cans and they should be marked accordingly. Using the zinc plate in conjunction with inverting the lidless cans while they are not in use has considerably increased their life on the Cleveland National Forest.—Fletcher Hayward, *District Ranger, Cleveland National Forest.*

PROGRESSIVE HOSE-LAY IN FIRE SUPPRESSION

STANLEY R. STEVENSON, *Fire Control Officer, and* EDWARD W. SCHULTZ, *Assistant Fire Control Officer, Cleveland National Forest*

A reanalysis of fire control requirements made in 1946 indicated that 70 percent of all fires on the Cleveland National Forest since 1934 (beginning of expanded tank truck use) were controlled at a perimeter of 20 chains or less through the use of tank trucks. This record of effectiveness of the use of water in fire suppression is further substantiated by regional studies. This reanalysis showed that three to five men with power water equipment controlled 5 chains per man-hour control time. This record of control was accomplished under conditions of maximum heat per unit of perimeter. The rate of perimeter control is 15 to 20 times greater than that of similar perimeter units where hand tools were used in line construction.

With this fact as a basis, we proposed to develop a means of placing water over a large and increasing perimeter of a hot brush fire with the same efficiency by expanding the crew.

Preliminary developments determined the problems to be solved in a practical application of the proposition as those of:

1. *Organization.*—An organization will be required that can function smoothly and fast. This demands that men, whose major experience with the use of water lies in initial attack suppression problems, be trained to operate as a large team on a hose-lay operation where the success of each phase is dependent upon every man.

2. *Water supply.*—A continuous supply of water must be available to the operation. This recognizes the present inadequacy of source of supply of tanker loads and the limitations of elevation upon delivery of water to a fire.

3. *Equipment.*—Efficient and modern power water equipment and large amounts of hose, hose-lay fittings, portable pumps, and accessories are needed. Original development of practictal aids will be required as problems are encountered.

4. *Strategy.*—A determination must be made as to what type of suppression problem the operation is adapted as limited by topography, cover, major sources of water, and burning conditions.

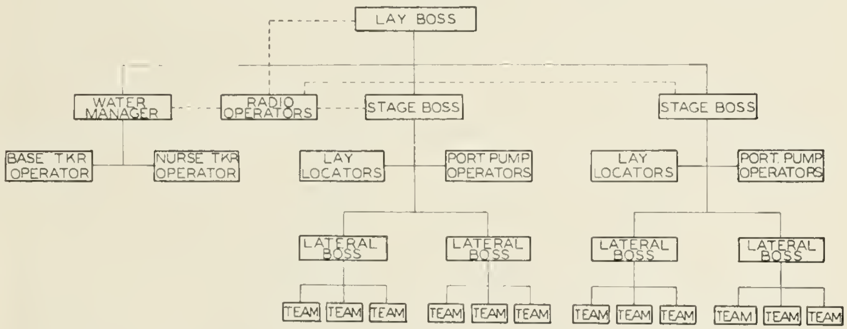
Toward the solution of these recognized problems, a preliminary plan of operations was made and executed in a 2-day meeting of experienced fire control men on the Cleveland National Forest. At this time, 1,500 feet of main-line 1½-inch hose with 100-foot 1-inch laterals every 200 feet, was laid by 7 men in 50 minutes; 2,000 gallons of water was used at an average of 10½ gallons per minute at each nozzle. No progression of manpower was made beyond the point where brush was wet enough to assume theoretical control. Water was available to all laterals, the base pumper being refilled by "nurse" tankers relaying water from natural sources.

The trial gave a control rate of 4 chains per man-hour, approximately the same rate as shown by initial attack tanker crews on small perimeters. The fact that good results were obtained with available equipment and little experience indicates the practicability of the operation.

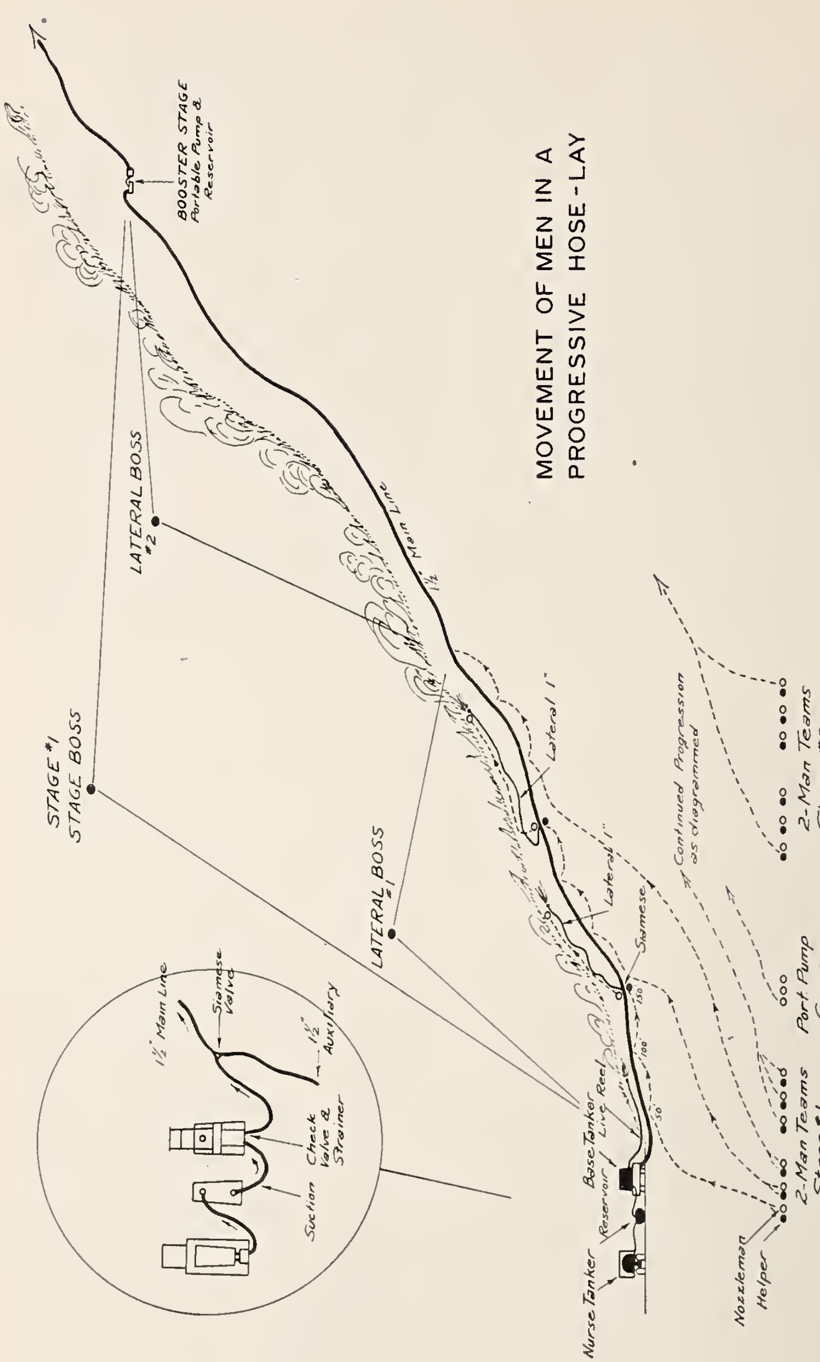
We have called the operation a "progressive hose-lay" and the control line created by it a "water scratch-line." It is fully recognized that this line is a temporary, fast, control line achieved only through progressive application of water to the growing fire perimeter, with control maintained by the lateral lines installed during progress. This line must be followed up with hand line construction to achieve complete and safe control. The hand-constructed line can progress directly on the fire edge with greater speed and without danger and fatigue from heat to the crews. The basic advantage of the progressive hose-lay is the ability to make direct attack on hot line with speed and safety, resulting in faster control. There is also a psychological stimulus to fire fighters in using water in fire suppression.

ORGANIZATION

The organization as shown was developed from trials and use on actual fires. It may be compared to a division organization on a large fire with suitable titles adapted to positions on a hose-lay. It may be expanded or reduced to sector, division, zone, or fire as necessary.



It is possible to place a team organization of this type on both flanks of a fire, progressing to tie in at the head. The lay boss (division boss) is responsible for the operation of one entire hose-lay of any length which has two or more water boosting stages. It is his general function to manage and coordinate all elements of the lay. The stage boss (sector boss) directs the laying of one stage. A stage is that length of hose-lay up to an elevation at which the lower pumping unit is limited in its water output by elevation or number of laterals. He is responsible for determining this point and providing a booster pump for continuation of the progressive hose-lay. The stage boss has several lateral bosses (crew boss), each in charge of three or more laterals as the problem demands. They are responsible for the smooth progression of their teams through the hose-laying procedure. As the size of the job to be done dictates, positions of water manager to coordinate base supply tankers and nurse tankers, lay locators to cut way-trails, lay inspectors to check for leaks and breaks in lay, and others may be added.


MOVEMENT OF MEN IN A PROGRESSIVE HOSE-LAY
BOOSTER STAGE
Portable Pump & Reservoir
LATERAL BOSS #2
1½" Main Line
STAGE #1
STAGE BOSS
LATERAL BOSS #1
Lateral 1"
Lateral 1"
Siamese
Continued Progression as diagrammed
2-Man Teams
Stage #2
Port. Pump
Crew
2-Man Teams
Stage #1
Nozzleman
Helper
Nurse Tanker
Reservoir
Base Tanker
Live Reel
50
100
150
1½" Main Line
Siamese Valve
1½" Auxiliary
Check Valve & Strainer
Suction

As in the performance of a football play, this organization must be keyed by men who know the progressive movements of its operation. When the initial attack crew recognizes that immediate control is not possible with available equipment and manpower, the scheme of progressive hose-lay begins with the decision that such an operation is adaptable to the suppression problem. Without waste of time on the usual lost efforts, they can initiate a main line lay and laterals with the hose and accessories available. Reinforcement crews provide additional water, equipment, and manpower to continue the progress of the lay around the fire edge. The Cleveland Forest has equipped a stakeside on each district with a large water tank and pump to provide the immediate need of a large volume of water, hose, and fittings to first reinforcements.

In the event of fast burning conditions continuing the increase of perimeter, fast dispatching of large reinforcements of manpower and equipment are necessary in Southern California cover types. Upon arrival of reinforcements on a fire reaching major proportions, with a control on the flanks initiated by the first crews, some men are placed in the organization to continue progressive water suppression to a point of control or tie-in with other operations. This procedure was successful on the two class C and two class E fires on which it was operated during the 1947 season on the Cleveland National Forest.

In the diagram the team units, consisting of two or three men, are the hose layers. A team starts their lay of 150 to 300 feet by connecting to the siamese valve at the end of the controlled portion of the fire perimeter. The 100-foot lateral at this point continues along the flank, knocking down the fire and making a water scratch-line. The team is able to lay their main line under the protection of this lateral. When they reach a point where the last lateral cannot protect them, they loop 50 to 100 feet of main line to the rear and install a siamese valve and lateral. The man on the last siamese valve is signaled for water by this team and as the nozzleman of the team receives water at the nozzle, he proceeds ahead continuing the water scratch-line. Manpower coming behind straightens the charged lines out as the nozzleman progresses. This procedure continues with additional teams carrying on in the same manner. Each team, upon completion of their lay, remains on the lateral, holding the fire edge and checking their lay for protection against hot spots. As soon as possible, they shut down and use water only for hot spots and flare-ups to maintain control of their line.

As the fire edge becomes cooler through the efforts of the lateral team and their siamese valve has given water ahead, the nozzleman can maintain control alone and the others return for more equipment to form another team.

Training of personnel for this operation is not one of the big problems. The coordinated progressive movement idea is mastered quickly. The key positions must be filled by men who understand the basic principles of hydraulics as related to hose-lays and are able to calculate and prepare for the limitations of equipment in moving water from point to point, up and down. If key positions are filled by trained men, completely inexperienced men can be used for laying hose with very little prior instructions.

EQUIPMENT

The trials and actual fire experience with equipment for this operation indicate that available equipment, with some adaptions, is adequate. For the base pumper operation the R–5 demountable tanker (Green Hornet) is the most efficient. It is desirable to install a shut-off valve on the 1½-inch outlet to prevent loss of water column in case of shut-down. A siamese valve with necessary adapters on the end of the first length of main line, installed backwards to provide an emergency switch-over to another pumper, is used successfully when the base tanker breaks down or needs servicing after long periods of pumping. This is necessary to maintain the uninterrupted flow of water to the main line.

Stakeside 1½-ton trucks with a 400- to 600-gallon tank and pump are used for nurse tankers: 425-gallon airplane wing tanks, made of rubber and canvas ply, anchored to the bed of the truck are also very successful. They have numerous outlets and with little work can be fitted with a pumping arrangement. These nurse tankers carry an additional empty wing tank, extra hose, siamese valves, nozzles, and a portable pump booster stage set-up. The extra wing tank is rolled off beside the base tanker for a reservoir. This reservoir is kept filled by relay nurse tankers.

The portable pumper stage set-up is available for boosting stages when the hose-lay has reached a point to which the last pumping unit cannot lift sufficient volume of water. It consists of a pump, packboard, canvas reservoir, and accessories. The fittings include a check and a bleeder valve and pressure relief valve.

Team pack units have been devised to solve the problem of men having their hands free to aid teams laying hose and proceed through brush without wrestling with rolls of hose and accessories. Each team has a packboard with separate ties for carrying three 50-foot lengths of 1½-inch CJRL hose and a packsack containing two 50-foot lengths of 1-inch CJRL hose, a siamese valve, and a nozzle with extra tips for the lateral installation.

The 1½-inch hose is double-rolled with male connector lapped by the female connector and double-tied with a one-pull release tie. The 1-inch hose is rolled by starting two separate rolls, side by side, from the middle of the length and tied in the same manner.

The most efficient siamese valves used are those with a single handle, well labeled, and equipped with an inverted cone type, self-releasing central control valve. They are carried with one 1½-inch to 1-inch adapter for the lateral line.

The recently developed Forester Fog Stream shut-off nozzle with its selective control over two streams is very efficient due to its light weight, compactness, simplicity, and double feature of water delivery. In using these nozzles, an in-the-line strainer is used at the base tanker and at intervals along the main line to prevent the fog outlet from becoming clogged with foreign material.

Continued use of the progressive hose-lay for fire suppression will determine the most adaptable equipment and create numerous aids toward its effective operation.

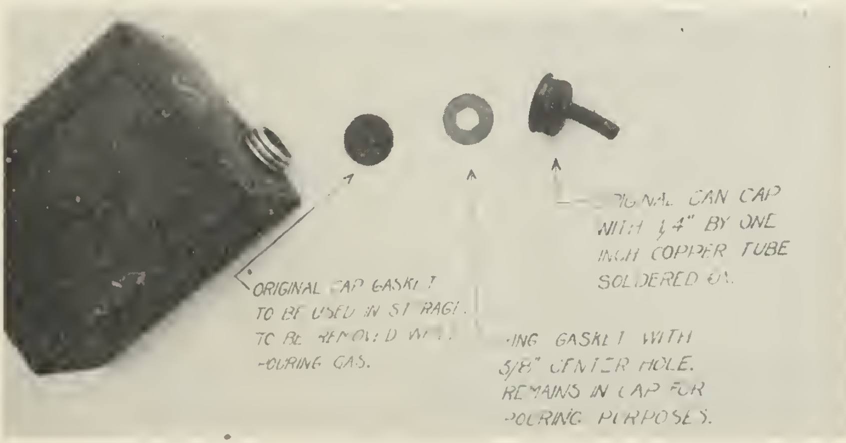
RESULTS ON TRIALS AND FIRES

The accompanying table shows the results of instances in which the progressive hose-lay was used during the 1947 season on the Cleveland National Forest.

Item	Trial 1	Trial 2	Fire 1	Fire 2	Fire 3
Size ... acres			10	623	90
Perimeter ... chains			60	450	200
Total perimeter controlled by progressive hose-lay ... percent			100 + spots	20	15
Length of lay ... feet	1,500	2,700	1,200	5,000	2,000
Elapsed time of lay ... hours	.8	.8	.5	2.0	1.0
Men on lay ... number	7	36	10	15	27
Perimeter per man-hour ... chains	4.1	1.1	12.0	3.0	1.1
Laterals installed ... number	7	18	3	17	14
Water pumped ... gallons	2,000	5,000	4,200	12,000	10,200
Difference in elevation ... feet	+300	+340	Level	+350	+320

Trial 1 was conducted by experienced fire control personnel accounting for the higher rate per man-hour as compared to trial 2 which was conducted for training inexperienced men. Fire 1 was a long narrow fire on which both flanks were controlled by the same laterals. Fire 3 results were attained by an organized "hot-shot" suppression crew who had received only 3 hours training in the operation on the morning of the day the fire occurred. The lay was made up a 65 percent slope covered with very dense brush where hand crews had withdrawn because of heat and danger.

Funnel Attachment for 1-Quart Gasoline Can.—The accompanying photograph shows a device that materially increases the usefulness of a 1-quart gasoline can for filling Coleman lanterns.



Safety rules prevent venting the can. With the funnel and gasket attachment, pressure can be applied to the sides of the can making in a "squirt" can. Anyone who has tried to fill lanterns without the funnel attachment will appreciate the improvement.

The spout can also be partially plugged to apply kerosene on crosscut saws.—Cleo Anderson, *Assistant Ranger, Cibola National Forest.*

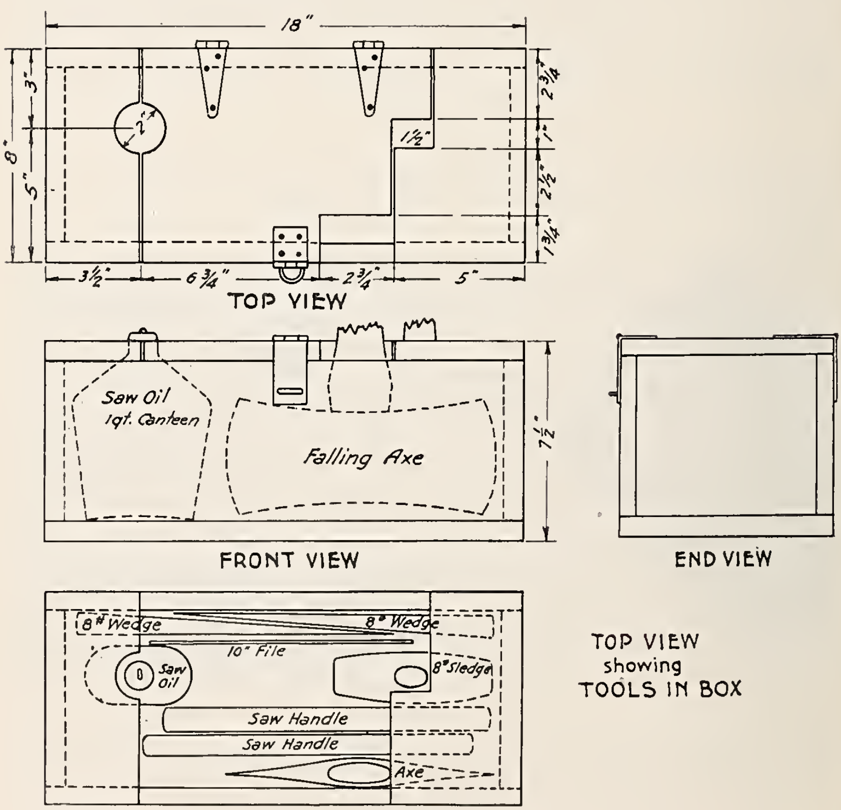
TOOL BOX FOR FELLING OUTFIT

James E. Taylor

Fire Control Assistant, Stanislaus National Forest, U. S. Forest Service

A safe practical box for storing and transporting a felling outfit was designed and constructed on the Calaveras District, Stanislaus National Forest, Calif. The box, which holds all of the necessary equipment except the saw and hard hats, is 18 inches long, 8 inches wide, and 7½ inches deep. The saw and hard hats are kept with it in the warehouse and are shipped to fires so all will arrive at one time and in good working order.

The dimensions of the tool box and method of tool arrangement are shown in the diagram.



FOAM

A. B. Everts

Fire Staffman, Snoqualmie National Forest, U. S. Forest Service

The intriguing characteristics of foam—its rapid expansion rate, its clinging and insulating qualities, as well as its spectacular performance on shipboard and oil-tank fires during and since the war years—stimulate the imagination as to ways and means of how this fire extinguishing agent can be efficiently applied to forest fire control. Manufacturers of foam and foam equipment have, for the most part, given little or no thought to the problems of forest fire agencies. There is a dearth of literature on the subject. D. P. Godwin, in the December, 1936, Fire Control Notes, reported a series of tests on the Monongahela National Forest which pointed out some of the values of foam. T. R. Truax, in the October, 1939, Fire Control Notes, reported the results of further field tests conducted by the Forest Products Laboratory.

However, the rather cumbersome methods of producing foam and the equipment needed, as in the one-powder, the two-powder, and the two-solution methods reported by Godwin, if not obsolete, have at least been greatly simplified by industrial research since 1936. While the author has nothing new to offer as to the practical value of foam in forest fire control he has had the opportunity to experiment with mechanical foam in back-pack cans, tank trucks, and pressure units. The method of application is simple. It remains for field tests to determine the value.

Types of Foam

The two principal types of foam are chemical and mechanical.

Chemical foam is a powder which is introduced into the hose line by means of a hopper or generator approximately 100 feet back from the nozzle. While equipment for its use has improved since 1936, the method of application is essentially the same as that described by Godwin. The quality of the foam is excellent but the employment of a hopper on an advancing fire line creates obvious disadvantages: the hopper must be moved along as the line advances and additional manpower is needed to pack the powder to and keep the hopper full. Other disadvantages are that the nozzle cannot be shut off, since to do so causes the water to back up in the hopper and force the powder out. Chemical foam is not as free flowing as mechanical foam and for that reason seems less desirable.

Mechanical foam is a liquid with a soybean base and other ingredients. It is dark in color and evil smelling, but unharmful to the

skin, clothing, or painted surfaces. It can be used with either fresh or salt water. The writer believes mechanical foam offers the best possibilities for forest fire work and, for that reason, the rest of this article will be confined to its use alone.

Cost of Foam

During the war the cost of foam to the Navy was said to be $11.50 per 5-gallon can. Since the war many hundreds of cans have been sold at $1 and some as low as $0.50 on surplus property sales. At this time the price seems to have stabilized at $22.50 per 5-gallon can. At this price few protection agencies can afford to use it except on those infrequent fires where its use will pay off. Even at this high price, however, which works out at approximately 2.2 cents per gallon of foam produced, it is a matter of record, as we shall see later, that 400 gallons of foam has been responsible for saving at least one and probably three dwellings from burning to the ground.

Characteristics of Foam

The characteristics of foam, which stimulate the imagination, are:

Expansion.—The rate of expansion varies with the pressure and size of the nozzle used. Foam can be produced with as little as 30 pounds pressure but best results are secured at 100 pounds. At 100 pounds pressure, the rate of expansion is approximately 10 to 1. The foam solution is mixed with the water at the rate of 6 gallons of solution to 94 gallons of water, and this mixture will produce about 1,000 gallons of foam.

Delivery.—The gallons-per-minute foam delivery also varies with the pressure and size of nozzle used. Delivery of up to 300 gallons per minute can be secured from 1-inch hose lines and up to 600 gallons per minute from 1½-inch hose lines. Thus a small fire can be quickly covered with a thick foam layer, blanketing out the oxygen.

Insulation.—The clinging characteristic of foam enables one to insulate logs, short snags (40 to 60 feet, depending on the nozzle used), buildings, and other material from the flames. The foam will stand up for an hour or more. The value of this property can best be illustrated by quoting from "The Use of Fog and Foam by Small Fire Departments" by Walter W. Stephen in the January 1946 issue of FIRE ENGINEERING. This articles states:

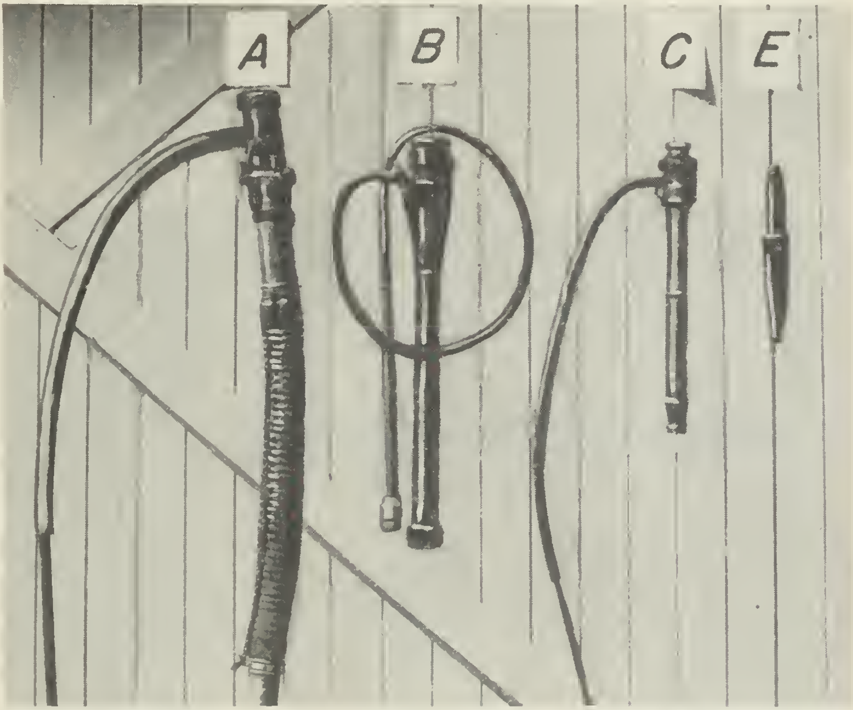
> A hose and chemical truck from an industrial plant went 4 miles out into the country to a crossroads community in response to a phone call. It was found that a fire, starting at one end of a row of five small one-story, frame, shingle-roofed dwellings, had involved two and seemed certain to destroy all of them. There was no source of water nor any apparent way to fight the fire.
>
> There was, on this piece of apparatus, a 40-gallon foam extinguisher. This was operated, and covered the exposed side and half of the roof of the third house with foam; these surfaces were scorching and smoking and about to "light off." The blanket of foam remained in place and protected and saved this house and the other two dwellings beyond it, while the first two that were on fire burned to the ground . . ."

At an expansion rate of 10 to 1, the 40-gallon extinguisher would have produced 400 gallons of foam. It seems very unlikely that these three buildings could have been saved with 40 gallons of water alone.

Methods of Introducing Foam Into Hose Line

There are several methods of introducing mechanical foam into the hose line.

Pick-up tube.—Four different sizes of nozzles are shown in the accompanying photograph. The first three have pick-up tubes. These are simply Venturi tubes designed to pick up the mechanical-foam solution at the proper proportion. The tube is inserted into a can of solution, and the movement of the water through the nozzle draws the solution into the base where it is mixed with air and water and thus produces foam. The disadvantage of this method is that, like the hopper used with chemical foam, cans have to be carried along the advancing fire line.



Nozzle *A* produces 540 to 600 gallons of foam per minute, using water at the rate of 56 and solution at 3.6 gallons per minute. Nozzle *B* produces foam at 300 to 500 gallons per minute. Nozzle *C* uses 15 gallons of water to produce 150 gallons of foam per minute. Nozzle *E* takes 2 gallons of water to give about 17 gallons of foam per minute; used on a back-pack can, this nozzle produces 32 gallons of foam with one quart of foam solution and the rest water.

Pick-up at the pump.—This method calls for special equipment and introduces the liquid on the suction side of the pump.

Pressure proportioner.—The proportioner comes in two sizes with capacities of 20 and 50 gallons respectively. Both sizes are dual compartmented so, while solution is being used from one compartment, the other one can be filled. Chief Ranger Rose of Mount Rainer National Park, a former Coast Guard officer, has mounted one of these proportioners on a tank truck and uses it for building protection.

Premix solution.—The fourth method is to mix the solution at the rate of 6 percent with the water in the tank truck. The pick-up tube can then be removed from the nozzle, as is also the case with the proportioner method. The disadvantage of this method is that once mixed the foam has to be used. Since foam will not be used on every fire on which a tank truck makes a run, it is obvious at once that this method is uneconomical. A fifth method is, therefore, suggested for use with tank trucks.

Pressure premix.—Experience has shown that either carbon dioxide (CO_2) or nitrogen gas is a good pressure medium for handling liquids. A light-weight pressure tank of desirable size, 18 gallons for a 300-gallon tanker and 30 gallons for a 500-gallon tank truck, could be mounted in any convenient location on the truck. This tank would hold pure foam solution. From this tank a 1-inch perforated pipe would run the length of the water tank. Connected to the foam tank a cylinder of CO_2 or nitrogen would furnish the pressure to quickly mix the foam solution and water. A pressure gage or pressure relief valve, preferably both, on the tank would provide safety. With this arrangement, a tank truck could quickly convert to foam whenever it was desirable to do so.

The 150-gallon-per-minute nozzle operates from ¾- or 1-inch hose lines and uses 15 gallons of water per minute. Note the insulating and clinging characteristics of the foam produced.

Foam Nozzles

No one has yet designed an adjustable foam nozzle. With the pressure premix method an adjustable nozzle could be used. Otherwise, one must choose the nozzle best suited for the job at hand. This would mean a tanker would need to carry several sizes, a large nozzle for building protection and heavy fuels, a smaller one for light fuels. Even nozzle *C* produces foam too fast for effective application on light fuel such as grass and pine needles. What seems to be needed for this fuel type is a nozzle of about 50-gallons-per-minute capacity. Such a nozzle would consume 5 gallons per minute of water. A 300-gallon tank truck would then operate for 1 hour while producing approximately 3,000 gallons of foam.

Fog-Foam

Fog-foam is produced by passing mechanical foam through a fog nozzle. In this case, the air is mixed with the foam-water solution by the impingement of the fog streams. Contrary to what one might expect the foam is not broken down. The rate of expansion is not 10 to 1, but more nearly 2 to 1. In other words, the capacity of a tank truck is about doubled. The advantage of fog-foam is that it offers the same personnel protection as fog. Its principal use is on airport crash fires and on fires involving volatile liquids. The Navy uses it in sprinkler systems in some cases. Used on light fuels there seems to be no question but that it is more efficient than fog alone. However, there is no proof that it is any more efficient than water fog reinforced with a wetting agent and certainly the latter is much cheaper.

Foam Equipment

As previously stated, manufacturers of foam equipment have given little thought to the forest protection agencies. The equipment that has been built is of a special nature designed for a special purpose. For example, at Midway (between Tacoma and Seattle) a group of citizens have had designed a 150-gallon trailer pressure unit. Pressure is furnished by CO_2. A Y provides two 1-inch hose lines. One line uses fog and the other foam (with the pick-up method). This unit is already credited with having extinguished six fires.

The White River Lumber Co. of Enumclaw, Wash., has a speeder unit also CO_2-pressured and using foam. The tank has a 40-gallon capacity (400 gallons of foam). It is used for patrolling behind logging trains.

This company is now building two 100-gallon CO_2-pressured foam units. These will be heavily reinforced with railroad steel and provided with slings. They will be spotted at skidder settings. If a fire starts at the back end of the operation, they will be hooked on to the skyline and run back to the scene of the fire. Each unit will have 500 feet of 1-inch linen hose and a 150-gallon-per-minute foam nozzle equipped with a shut-off.

Other Possibilities

The writer has proved to his own satisfaction that it is possible to lay a foam line from a moving tank truck, and to backfire this line all in one operation. However, from the economic standpoint it is not feasible. It takes about 1 gallon of foam per linear foot in light fuels. Thus a 300-gallon tank truck could lay only about 3,000 feet of line. The same thing can and has been done with fog and the distance is more than tripled without adding the cost of the foam solution. Application for patent on the latter idea has been made.

And while we are speculating, another idea presents itself. It is not impossible that the future will see helicopter foam tankers. Such a unit might work as follows: The helicopter will take one or two men into a fire. After landing them, the pilot will return to the nearest road where, by prearrangement, he will meet a tank truck. He will land and fasten a canvas reinforced tank to his landing gear. This tank will be filled with water and foam in proper mixture. There will be 250 feet of plastic or linen hose equipped with a foam shut-off nozzle. The helicopter will then return to the fire. The hose line will be lowered and the machine rise to 200 feet. This altitude will be sufficient to provide about 100 pounds nozzle pressure. The ground men will then apply the foam to the fire. Or perhaps water-fog and a wetting agent will be just as effective.

Summary

In conclusion, then, we see that in discussing foam we must not overlook fog, especially wetter water fog. Each type of extinguishing agent has its place. It is a matter of knowing your equipment and what it will do. It should not be too far out of line to say that, considering cost, foam should be of value for:

(*a*) Back-pack cans where the addition of foam solution will produce 32 gallons of foam.

(*b*) Those agencies which, in addition to forest fires, are also charged with the responsibility for rural building protection.

(*c*) Agencies which operate along heavily used truck highways where the danger of large gasoline tankers catching fire can be expected. Fog will handle gasoline fires only if the entire burning area can be covered with fog, or in enclosed places where the effect of the steam produced aids in extinguishment. Foam, on the other hand, can be made to flow over the burning gasoline and bring about control.

Support for Canvas Relay Tank.—The portable tank used in relaying water from one pump to another can be made to stand alone by using one end of the standard folding canvas cot frame. By removing one end of the cot, leaving the other end and the middle legs, two sides and the uprights are formed. The other two sides of the frame can be made from the two end braces by trimming them flush with the sides. The framework folds and can be placed inside the tank before it is folded for storage.—Richard Raybould, *Fire Crew Foreman, Cleveland National Forest.*

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

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FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 9 Numbers 2 and 3

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TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Contents

FIRE LINE SAFETY

Seth Jackson

Administrative Officer, Washington Office, U. S. Forest Service

Probably nothing short of war is potentially more risky to life and limb than fire on the rampage. Miramichi, Peshtigo, Phillips, Hinckley, Baudette, 1910, Cloquet, Maine—these are names of spectacular forest fires. They resulted in many deaths and untold injuries to the public at large.

Less spectacular are the smaller fires which year after year maim or kill men fighting them—less spectacular, but just as serious to these men and their families. Besides the personal suffering, these injuries cause a large economic loss; loss of pay to the worker while he is off the job; medical and hospital bills to the employing agency; damage to equipment and material; and many indirect losses such as decreased production and lowered morale on the fire line.

Experience in the Forest Service shows that about a third of its injuries and deaths come from fire control activities. In addition to the 11 men killed as a result of Forest Service fires in the past 2 years, at least 25 men have been killed on State or private fires.

How do fire fighters get hurt? In fire fighting the two basic causes of most accidents—unsafe working conditions and unsafe acts—are always exaggerated. Take the case of the man who cuts his foot with an ax, one of the most common injuries on the fire line. The unsafe condition could be an ax in poor shape, poor footwear, poor footing, not enough area cleared for ax swing; the unsafe act, standing too close or too far from whatever is being cut, striking a glancing blow.

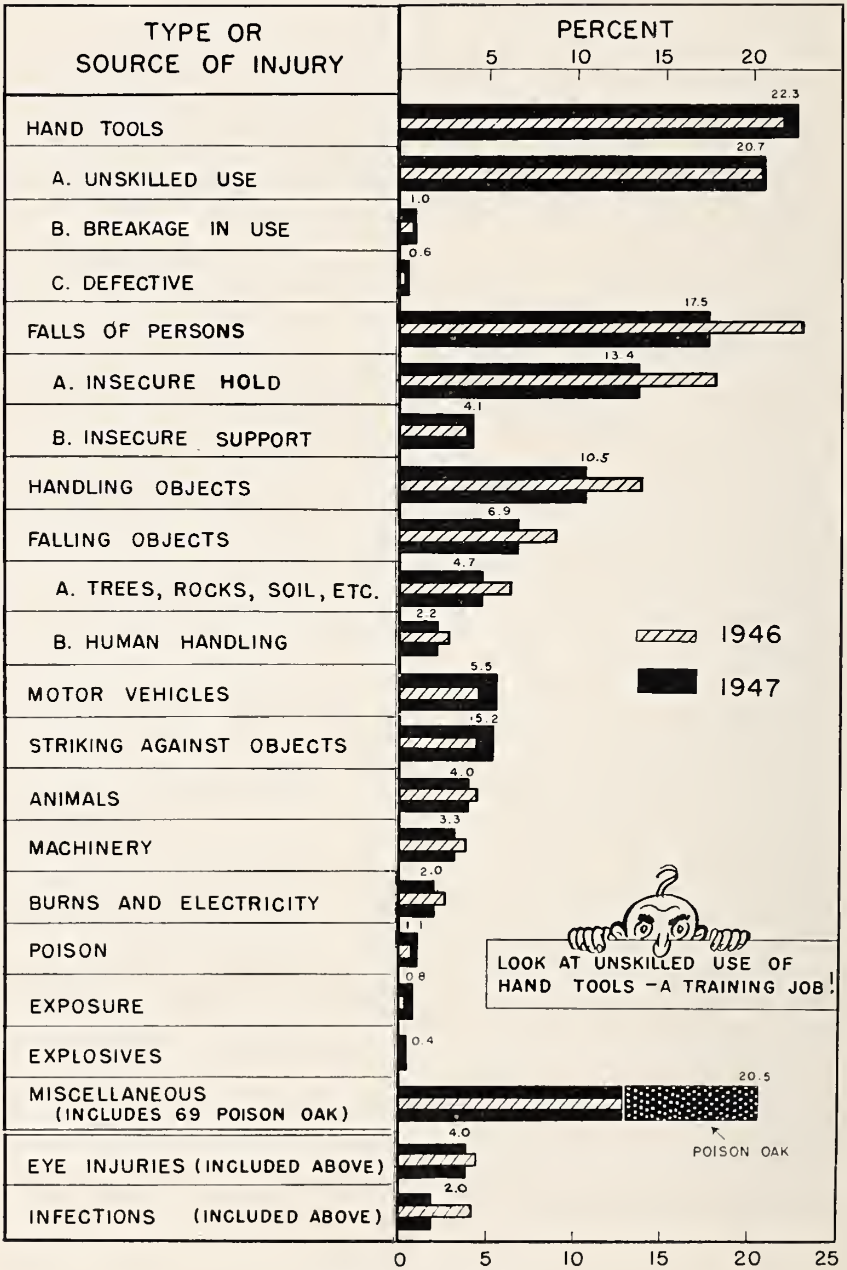
Another frequent cause, also a combination of condition and act, comes from slipping, stumbling, falling. Many cases of men being trapped on fires are attributable to this. Rolling rocks, logs, falling trees or branches—falling objects—result in many injuries and deaths. Less frequent but usually very serious are injuries due to machine equipment, such as jeeps, trucks, tractors, or bulldozers, getting out of control. The trend toward mechanization in fire fighting will increase the severity of this problem.

Land planes, seaplanes, and helicopters are going to be used more and more. Here carefully developed accident prevention plans will help to make the fire fighting game less exhaustive and safer. The helicopter especially shows great promise this way.

Curiously enough, no Forest Service smoke jumper has been killed on the job. There have been only 134 lost-time injuries on the 7,407 jumps made since 1943. Wind, an unsafe condition, played an important part in these injuries.

In general, fire-injury causes are similar to those indicated in the chart for all Forest Service work.

The accident situation is aggravated in fire control by several factors. The job is done under emergency conditions where minutes count and safety is often lost sight of. Large numbers of "green hands" must be put to work promptly without the benefit of experience or training in woods work. Under these conditions some accidents are inevitable.



Injury type analysis.

But the accident toll depends on what we do to keep it down. Four courses of action are necessary to eliminate those unsafe working conditions and unsafe acts which are basically behind most accidents.

First, of primary importance in any safety campaign, *enlist the full support of top management.* In fire suppression this means the demonstrated interest and active participation in accident prevention by all work supervisors, from Division Chief and fire bosses to straw bosses. Workers will do what their bosses want them to do. The bosses must set the example.

Second, *include safety in all fire planning.* If safety is set up as a separate job to be done when time permits, the chances are it will be overlooked when the emergency comes.

Fire controllers must be intent on methods and speed. Safety can help both if it is planned that way. Usually the safe job is the most efficient in the long run. Here are a few suggestions for fire control planning.

1. Analyze accidents, then plan the job to prevent recurrences.
2. Make safety a part of every job. Until everybody is reasonably safety conscious, accident rates will remain high.
3. Plan ahead to prevent excessive overtime. Provide in advance for overhead and worker relief on fires, and for safe traveling to and from the job, especially at night.
4. Calculate human risks. Some areas might even be abandoned where the hazards are too great and the values too low.
5. Consider assigning a man full time to accident prevention and first aid on all large fires. The usual need for overhead on a fire may overshadow this, but is this not shortsighted? An injured man is at least a double liability on a fire. He is out of service and it usually takes one or two others to care for him. A safety man will help cut down on this loss.
6. Provide for safety in all equipment development and use. Are the tractors equipped with overhead guards for protection against falling snags or branches; are their tracks so guarded that there is no danger of foot injuries; and would a handrail or step make it safer to get on and off? Should the men have better eyeshields and smoke masks, or foot and leg guards for glancing axes? The field of personal protective equipment in the woods is almost unlimited, and not greatly developed.
7. Make brief safety check lists as aids to prevent accidents.

Third, *emphasize safety when recruiting.* Prior understanding with employing agencies and recruiting officers to select only those men who are physically fit and properly clothed for fire fighting will help eliminate accidents. This also applies to recruiting overhead from among permanent employees.

Many accidents come from failure to recognize potential danger. So consider mental outlook on safety when recruiting fire bosses, foremen, and straw bosses. Previous experience and training has much to do with this, which brings us to our fourth course of action.

Integrate safety in all job instruction. Safety key points need emphasis with fire overhead as well as fire line labor. Take advantage of all available minutes to stress safety, especially during their first hour on the job. They will never need help more, nor be more willing to accept it, than when they first start work. Train them to meet the job hazards.

What's the best way to do this? First, get your thoughts in order for a safe job when planning ahead. Then arouse the worker's interest. This should not be too difficult when one's life might be in the balance. Next tell, show, illustrate what you want him to do, one step at a time, always stressing safety. Then let him do it under close coaching. Finally, test him on the job. Follow up frequently. If the worker hasn't learned, the instructor hasn't taught.

Follow up—two very important words in job instruction and accident prevention. All too often they are forgotten. But if you want a top-notch safety job, don't forget to follow up.

Now let's summarize. To prevent accidents on the fire line we can—

1. Get active safety support from top management.
2. Include safety in all fire planning.
3. Emphasize safety when recruiting.
4. Integrate safety in all job instructions.

Finally, a word to work supervisors, don't forget to follow up!

Well's Tree-Marking Gun and Back-Firing Torch—Explosion Hazard Tests.—Explosion hazard tests have been completed by the National Bureau of Standards of the Well's tree-marking gun and back-firing torch, which was described in Fire Control Notes, October 1947, page 21. The Bureau's report is summed up as follows:

"The results of the tests showed that in the torch, as represented by the sample submitted, the likelihood of explosion inside the tank by ignition through the nozzle is remote. However, in the Bureau's opinion, a fine-mesh screen (preferably conical in shape and made of brass or bronze wire) should be inserted in the base of the nozzle to prevent particles of dirt or scale from clogging the discharge orifice. This screen would act as a flame arrestor. In the condition as received, it was not possible to obtain a satisfactory flame-throwing performance of the torch. The nozzle was taken apart and a particle of foreign material removed from the orifice in which it had lodged.

"In general, any device which uses a fuel of which one-half is gasoline is hazardous in the presence of flame as in this torch, even with safeguards. It is suggested that fine-mesh wire screen be inserted under the filler cap in the manner found in safety cans for gasoline to prevent an explosion if filling is done in the presence of fire. It would be desirable to instruct each operator as to possible hazards and give precautions as to its use."—DIVISION OF FIRE CONTROL, *Washington Office, U. S. Forest Service.*

THE HELICOPTER—BELL MODEL 47B

IRA C. FUNK, *Mechanical Engineer, Region 5, U. S. Forest Service*, and FRED W. MILAM, *Operations Officer, L. A. Airways, Inc.*

This article is intended as a companion article to The Helicopter—A New Factor in Fire Control by Frank J. Jefferson appearing in the January 1948 issue of Fire Control Notes. It is based directly on Equipment and Development Report Number 12 of the Forest Service, United States Department of Agriculture.

All helicopter tests conducted to date by the Forest Service have shown that present-day helicopters have fairly definite limits of performance in mountainous country. That is, they can be depended upon to carry a full pay load to or from landing spots up to certain elevations. For landing spots above this elevation the loading must be reduced. Air temperature, wind, and other conditions at the landing spot greatly affect the amount of loading that can be safely carried.

Every one interested in the application of the helicopter to fire control and other work as well should become familiar with terminology used and the limits of operation of each make and model. Safety is a prerequisite in fire control as well as in other work and such a familiarity will aid in the prevention of accidents when using the helicopter.

DEFINITION OF TERMS USED IN HELICOPTER OPERATION

Pressure altitude is the altitude indicated by the aircraft altimeter when barometric corrector is set at 29.92 inches of mercury (N. A. C. A. standard barometric pressure at sea level).

Density altitude is the altitude under N. A. C. A. standard air conditions. True altitudes under field air conditions may be converted to the density altitudes having the same air density. Conversion of true altitude to density altitude is based on barometric pressure and air temperature. Conversion of pressure altitude to density altitude is based upon temperature only (table 1). In conversions, for the

TABLE 1.—*Density altitudes for different pressure altitudes*[1] *at various free air temperatures*

Pressure altitude (feet)	Density altitude when free air temperature is—							
	30° F.	40° F.	50° F.	60° F.	70° F.	80° F.	90° F.	100° F.
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
0	-----	------	−700	0	600	1,200	1,900	2,500
1,000	−500	100	700	1,200	1,900	2,500	3,200	3,800
2,000	700	1,300	1,900	2,500	3,100	3,700	4,400	5,000
3,000	1,900	2,500	3,200	3,800	4,400	5,000	5,700	6,300
4,000	3,200	3,800	4,400	5,000	5,700	6,300	6,900	7,500
5,000	4,500	5,100	5,700	6,300	6,900	7,500	8,200	8,800
6,000	5,700	6,400	7,000	7,600	8,200	8,800	9,400	10,000
7,000	7,000	7,600	8,200	8,800	9,400	10,000	10,700	11,300
8,000	8,200	8,900	9,500	10,100	10,700	11,300	11,900	12,500
9,000	9,400	10,000	10,700	11,300	11,900	12,500	------	------

[1] For application in field, pressure altitude of landing spot may be assumed as equal to surveyed elevation for same.

same true altitude, summer temperatures have a greater effect than barometric pressures. Since all aircraft specifications are based upon N. A. C. A. standard air, all altitudes or ceilings given in such specifications are density altitudes.

True altitude is the measured or surveyed altitude or elevation above sea level.

Hovering with ground effect is the flight of a helicopter with zero air speed near enough to the ground or water surface to compress a cushion of high density air between the main rotor and the ground or water surface, thereby increasing the lift produced by the main rotor. Usually the main rotor must be within one-half of the rotor diameter of the ground to produce a ground cushion.

Hovering without ground effect is the flight of a helicopter with zero air speed at sufficient height above the ground or water surface to prevent the formation of an air cushion between the main rotor and the ground or water surface.

Translational lift is the lift supporting the helicopter due to the translational displacement of the craft through the air, that is, through air speed. When the helicopter is hovering or has zero air speed, under no wind condition, it has no translational lift.

Spot take-off is the take-off from hovering, usually with 2 to 3 feet ground clearance, from a landing area having a diameter about twice the greatest over-all dimension of the helicopter. The normal flight path of a helicopter on spot take-off is similar to that of a conventional airplane except the angle of climb is greater and no ground run is required.

Spot landing is the landing of a helicopter in a landing spot having a diameter of about twice the length of the helicopter.

Running take-off is the take-off of a helicopter running its wheels on the ground until sufficient air speed and translational lift are gained to permit taking off with maximum rate of climb. When operating at such high altitudes that the helicopter cannot hover, a running take-off may be necessary.

Running landing is a landing similar to that of conventional aircraft. When operating at such high altitudes that the helicopter cannot hover, it is necessary to maintain translational lift through air speed until after the wheels are on the ground.

Autorotation is the power-off operation of a helicopter in which the helicopter becomes an autogiro. By means of a free-wheeling unit the rotor is disengaged from the engine and lift is obtained through the windmilling of the blades. This is a standard maneuver which can be used for descent and emergency landings in all helicopters. Autorotation emergency landings are made in case of engine failure.

Revolutions per minute (*r. p. m.*), unless otherwise stated in this report, is engine speed in revolutions per minute.

Center of gravity (*c. g.*) is the longitudinal center of gravity of the helicopter with loading. The location of the center of gravity is the point at which the entire gross weight of the helicopter can be considered as being concentrated for the purpose of determining balance.

Gross weight is the total weight of the aircraft including pilot, passengers, cargo, fuel, oil, and any other loading carried by it.

Empty weight is the total weight of the aircraft with specified normal equipment but without residual fuel and oil, fuel and oil in tanks, pilot, parachutes, passengers, cargo, or special test equipment.

Useful load is the total weight of pilot, passengers or cargo, residual fuel and oil, and oil and fuel in tanks. This includes all loading not included in the empty weight.

Pay load is the total weight of passengers or cargo. It does not include fuel, oil, or pilot's weight.

Critical performance is the performance of a flight operation under conditions making the operation hazardous or impossible with normal power settings and flight procedure. Such flight operations can be safely accomplished if above normal engine revolutions per minute and experienced pilot technique are applied. Spot take-off and landings are classified as critical if more than normal engine revolutions per minute is necessary, or if hovering clearance, with normal engine revolutions per minute (3,000 revolutions per minute for Bell Model 47B) and full throttle, is less than 3 feet.

Easy performance is the performance of a flight operation under conditions that allow the operation to be accomplished with safety by experienced pilots with normal power settings and flight procedure.

TEST OPERATIONS OF THE BELL MODEL 47B

Tests were made to determine the pay-load capacities of the Bell Model 47B helicopters (figs. 1 and 2) in mountainous areas up to a maximum surveyed ground elevation at which the helicopter could make a spot landing and spot take-off with reasonable pay load, and with normal power. This included (1) determining the maximum gross weight for hovering, landing, and taking off from a small land-

FIGURE 1.—Bell helicopter, model 47B, hovering.

789077—48——2

FIGURE 2.—Bell helicopter, model 47B, cabin arrangement.

ing spot with the wind velocity less than 5 miles per hour; and (2) checking tentative landing spots by flying a simulated landing approach (10 miles per hour above the indicated air speed necessary to maintain level flight at specified density altitudes) on the tentative landing spots.

This project is supplemental to the cooperative project conducted by the Air Rescue Service of the United States Army Air Force and the Forest Service, United States Department of Agriculture, with the Sikorsky (Army R5–A and R5–D) helicopters in 1946.[1] The flying of the Bell helicopter was performed under contract by the Armstrong-Flint Helicopter Co., Pacoima, Calif. The pilots of these tests were Knute Flint and Fred H. Bowen, both experienced helicopter pilots.

Normal procedure and power settings in tests for spot take-off were as follows: Helicopter was brought to a hovering position with from 1 to 3 feet ground clearance. Forward motion was maintained with this ground clearance until sufficient air speed (approximately 25 miles per hour, I. A. S.) was gained to establish translational lift. Usually 40 to 90 feet travel is necessary. Engine revolutions per minute may vary from 2,950 to 3,050, depending on density altitude, gustiness, and other atmospheric conditions, and how the ship feels to the pilot. After translational lift was gained, pitch was increased

[1] FUNK, IRA C., and KNUDSEN, CARL S. HIGH LIGHTS FROM RESULTS OF HELICOPTER TESTS. Fire Control Notes 8 (1): 10–16, illus. 1947.

mainly to reduce the engine to 3,000 revolutions per minute (usually at full throttle), and at the same time to give necessary climb while indicated air speed was further increased to at least 45 miles per hour. The remainder of the climb was at 3,000 revolutions per minute and at full throttle.

Normal procedure and power settings in tests for spot landings were as follows: Final approach was entered about 200 feet above the landing spot at 45 to 50 miles per hour with approximately 2,950 revolutions per minute. Descent was maintained so that on arrival at edge of landing spot clearance was 15 to 20 feet. Revolutions per minute was increased at this point to a maximum of 3,000 as air speed was reduced nearly to zero. At the same time, pitch was increased to check rate of descent. As soon as the ground cushion was established, pitch and power settings were reduced slightly to effect and maintain a hover. The helicopter was then let down to the ground by further reducing pitch and power settings.

Specifications of Bell Model 47B

Gross weight: 2,200 pounds.
Empty weight: 1,251 pounds.
Useful load: 679 pounds.
Allowable fore and aft displacement of c. g. (total inches): 4.88 inches.
Seating capacity:

Pilot: 1
Passenger: 1.

Fuel and oil capacity:

Fuel: 33 gallons.
Oil: 2 gallons.

Engine, Franklin, 6V4–178–B3: 178 horsepower.
Controls: Dual.
Dimensions:

Over-all length (main rotor over tail rotor): 41 feet 2.5 inches.
Over-all height: 8 feet 6 inches.
Over-all width over stabilizer: 8 feet 6.7 inches.
Main rotor diameter: 35 feet 1.5 inches.
Tail rotor diameter: 5 feet 8.1 inches.
Alighting gear width: 6 feet 6 inches.
Cabin width inside: 4 feet 3 inches.
Cabin height inside: 4 feet 4 inches.
Tail rotor ground clearance: 3 feet 3 inches.

Performance with design gross weight

Maximum speed at sea level: 92 miles per hour.
Cruising speed at (75 percent b. hp.): 75 miles per hour.
Maximum rate of climb at sea level (45 miles per hour): 950 feet per minute.
Hovering ceiling without ground effect: 3,200 feet.
Service ceiling (rate of climb 100 feet per minute): 9,700 feet.
Fuel consumption cruising (approximately): 12 gallons per hour.

Maximum allowable gross weight for operations under various temperatures and elevations is given in table 2. Similarly pay-load values are given in table 3. Pay loads given in table 3 may be increased approximately 70 pounds when the wind at the landing spot is steady at 11 to 15 miles per hour and approximately 60 pounds when the landing spot is on a ridge top and thus permits flat approach and take-off and application of above normal engine and rotor revolutions per minute for a brief period.

TABLE 2.—*Maximum allowable gross weight for spot take-off and landing at specified pressure altitudes,*[1] *with wind velocity 0 to 5 miles per hour*

Pressure altitude (feet)	Gross weight when free air temperature is—							
	30° F.	40° F.	50° F.	60° F.	70° F.	80° F.	90° F.	100° F.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,200
1,000	2,200	2,200	2,200	2,200	2,200	2,200	2,200	2,185
2,000	2,200	2,200	2,200	2,200	2,200	2,195	2,135	2,080
3,000	2,200	2,200	2,200	2,185	2,135	2,080	2,020	1,970
4,000	2,200	2,185	2,135	2,080	2,020	1,970	1,920	1,865
5,000	2,125	2,075	2,020	1,970	1,920	1,865	-----	-----
6,000	2,020	1,960	1,910	1,860	-----	-----	-----	-----
7,000	1,910	1,860	-----	-----	-----	-----	-----	-----
8,000	-----	-----	-----	-----	-----	-----	-----	-----

[1] For application in field, pressure altitude of landing spot may be assumed as equal to surveyed elevation for same.

TABLE 3.—*Maximum pay load*[1] *for spot take-off and landing at specified pressure altitudes*[2] *with wind velocity 0 to 5 miles per hour*

Pressure altitude (feet)	Maximum pay load when free air temperature is—							
	30° F.	40° F.	50° F.	60° F.	70° F.	80° F.	90° F.	100° F.
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	375	375	375	375	375	375	375	375
1,000	375	375	375	375	375	375	375	360
2,000	375	375	375	375	375	370	310	255
3,000	375	375	375	360	310	255	195	155
4,000	375	360	310	255	195	155	95	40
5,000	300	250	195	155	95	40	---	---
6,000	195	145	85	40	---	---	---	---
7,000	85	40	---	---	---	---	---	---
8,000	---	---	---	---	---	---	---	---

[1] Pay load allowing fuel for 100 miles range (16 gallons plus 4 gallons reserve), 170-pound pilot, and 2 gallons of oil.
[2] For application in field, pressure altitude of landing spot may be assumed as equal to surveyed elevation of same.

The pilot's weight is normally considered as 170 pounds. This was assumed in computing table 3. When the pilot's weight is 160 or 150 pounds, the pay load may be increased 10 or 20 pounds, respectively, over the amounts given in table 3.

Total fuel, including reserve, is 20 gallons (permitting operation for 80 minutes or 100 miles). By reducing fuel load to 16 gallons (60 minutes or 75 miles) the pay load may be increased 30 pounds. For a fuel load of 10 gallons (30 minutes or 38 miles) the pay load may be increased 60 pounds over the value given by the table.

Since conditions of landing spots affecting landing techniques vary so widely in mountainous areas, pilots must be highly experienced. Personnel directly supervising helicopter operations should have a thorough knowledge of helicopter flight characteristics and know how various factors affect their load limitations. The importance of this is illustrated by the following example.

On the Bryant Fire, Angeles National Forest, experienced pilots gradually increased loading and landing elevations until between 200- and 250-pound pay loads were carried to a ridge top landing spot having an elevation of 5,300 feet. Temperature was approximately 80° F. and wind velocity was steady at 11 to 13 miles per hour.

Application of the data given in this report indicates the maximum allowable pay load under the conditions on the Bryant Fire to be as follows:

	Pounds
Maximum pay load from table 3	40
Increase due to wind (11 to 13 miles per hour)	70
Increase due to ridge top landing spot and highly experienced pilots, and use of above normal revolutions per minute	60
Increase due to low pilot weight (150 pounds)	20
Increase due to low fuel (15 gallons)	36
Total pay load	226

Regardless of the helicopter's ability to lift a greater load, the gross weight of the Bell Model 47B should never be permitted to exceed 2,200 pounds, its licensed limit.

Landing spot requirements.—The Bell Model 47B is unusually stable in flight, and may be landed and taken off from a spot where small obstacles clear its over-all dimensions by only a few feet. Pilot fatigue is comparatively low for a helicopter.

Further study of the Bell helicopter's take-off flight characteristics is needed to determine definite landing spot requirements. Highly experienced pilots, with mountain operation experience, are capable of selecting landing spots that in most cases require little or no improvement before being used.

Experience to date, however, indicates that before any helicopter landing spots are chosen, the tentative spot should be checked *from the air by a helicopter* to determine if the approaches and take-off patterns are suitable. This cannot be done by a conventional type airplane since it is impossible to slow the airplane down to the speed that the helicopter would be flying on take-off and landing patterns. During the tests it was found that suitable landing spots could be located from the helicopter that appeared to be unsuitable when observed from conventional aircraft and from examination of aerial photographs and topography maps. Before a final decision is made to improve a landing spot, the spot must be checked on the ground to determine the amount of slope of the landing area. The Bell Model 47B does not have brakes on the landing gear, and so requires level ground where the helicopter is to stand.

There is little justification for expenditures in planning helicopter operations and preparing helicopter landing spots until helicopters are available for reconnaissance in connection with such planning work.

Maintenance.—At present there have not been sufficient Bell Model 47B helicopters in operation to give an accurate estimate of the required maintenance cost and depreciation. Under present CAA regulations it is necessary to magnaflux or zyglo inspect all parts of the rotor head and gear boxes every 100 hours. Undoubtedly, this will not be necessary as the flying time on the helicopter increases. At present it requires approximately 160 man-hours for a 100-hour inspection. This time will be reduced as experience is gained by the maintenance crew and certain precautionary measures are withdrawn by CAA. There are also a few mechanical problems that must be worked out before this helicopter could be depended upon to meet a rigid flying schedule day after day over a period of a month or longer.

The present contract cost is $50 to $70 per hour of flying time. The rate depends mainly on whether landings are to be made at unimproved spots, a factor which increases maintenance of the helicopter.

Suggested improvement of the Bell Model 47B helicopter.—The following improvements are needed on the Bell Model 47B in order to make it fully effective in all forest areas, especially where landing spots are between 4,000 and 9,000 feet, as in national forests located in Montana, Idaho, and the Pacific Northwest:

1. Increase hovering ceiling.
2. Increase service ceiling.
3. Raise tail rotor to clear higher obstacles.
4. Revise landing gear to increase clearance between fuselage and ground.
5. Provide parking brake.
6. Provide easy removal of controls from one seat.
7. Improve carburetor air filter for operating in extremely penetrating dust and ash conditions in burned over areas.
8. Provide cargo racks: in passenger's seat for such things as blankets, canteens, etc.; on floor for such things as small tools; on exterior of cabin for such things as long handled tools, shovels, and saws.
9. Provide hopper arrangements for dropping water in direct fire suppression
10. Provide stretchers on side of helicopter for evacuating injured.

CONCLUSIONS

The tests made indicate that the Bell Model 47B helicopter, when flown by pilots that are highly experienced in operating helicopters in mountainous areas, is suitable for fire control operations up to an elevation of 6,000 feet where landing spot conditions are most favorable. In timbered areas with few bald ridge top spots for landing, its usefulness becomes limited. However, in the most diffcult situation, the Bell Model 47B can be depended upon to carry suitable pay loads to and from landing spots having elevations up to 3,200 feet and limited loads of strategic supplies to or from landing spots at higher elevations.

Plastic for Osborne Fire Finder Map Covers.—Another use was found for the versatile plastic on the Cleveland National Forest this season. A circular disk from $\frac{1}{16}$-inch Lucite, similar to Plexiglass, was used over the map on both Osborne and Bosworth fire finders to aid in preserving the maps and to hold the map in place. The disks should be cut approximately $\frac{1}{8}$-inch smaller than the tin map disk to allow it to fit inside the disk screws and still be held in place by the heads of the screws. By use of the disks the task of gluing the map to the tin is eliminated, as a few strips of tape will hold the map to the tin and the weight of the plastic will hold the map flat. The advantage over glass is that the plastic won't break and is easily cut. But care must be used not to scratch the plastic. Most scratches can be removed with polishing rouge.

The same plastic material is also used for call card covers in radio equipped automotive equipment.—STANLEY STEVENSON, *Fire Control Officer, Cleveland National Forest.*

OBSERVATIONS ON FOUR PRESCRIBED FIRES IN THE COASTAL PLAIN OF VIRGINIA AND NORTH CAROLINA

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The following article by Mr. Kenneth B. Pomeroy is a factual report of four prescribed burning experiments covering relatively small areas in the North Atlantic Coastal Plain designed to determine whether or not burning under controlled conditions would hasten reseeding of pine on areas where noncommercial hardwoods constituted the bulk of the stand prior to burning. The article is merely a factual report and is published here to make these facts of permanent record. It is not intended to carry a definite recommendation as to the widespread application of the principle of prescribed burning to secure seeding of loblolly pine in North Atlantic coastal areas where noncommercial hardwoods act as a deterrent to pine regeneration. The article is being published in Fire Control Notes because of the widespread interest in prescribed burning for silvicultural reasons.

Wide publicity has been given the use of fire as a silvicultural tool. Some foresters advocate prescribed burning for the improvement of seedbed conditions and as a means of reducing the competition from inferior species during the critical period of reproduction establishment. Other foresters contend that prescribed burning should not be encouraged while they are still trying to sell fire prevention to the public; that the sprouting ability of many hardwood species limits the duration of any reduction in crown competition; and that the release and preservation of existing seedlings will be the most economical means of stand regeneration.

Consequently, prescribed burning is a topic of considerable interest to foresters in the North Atlantic Coastal Plain. It was this trend toward more intensive forest management, concern over hardwood invasion, and unsatisfactory pine regeneration that prompted four organizations, three commercial and one Federal, to try prescribed burning during the fall of 1946.

THE TRACTS BURNED AND RESULTS OBTAINED

Tract 1

This 15-acre tract had been in a cut-over condition for 4 or 5 years. The seed source was ample, being 7 or 8 loblolly pine per acre, 16 to 20 inches d. b. h. Very few pine seedlings could be seen in the dense ground cover of young hardwoods, shrubs, and vines. Because of frequent summer and autumn showers, it was October 7 before weather conditions were judged to be right for burning. The intent was to burn as early in the fall as weather conditions would permit, because

the seed trees were heavily laden with cones. Vegetation was in the transition stage. A 5-mile-per-hour wind was blowing from the north. Although no fire-danger station was being maintained in the vicinity, the fire danger was probably class 3.[1] The risks common to the use of fire were emphasized when all available manpower (eight men) had to be mustered to control a breakover along the fire line. The 6-inch furrow, prepared with a turning plow, was inadequate, partially because roots had caused the plow to skip. Seed trees 80 to 100 feet tall were damaged when the fire flared up higher than had been expected. Seven months later two of these trees were dead and four other had lost more than 75 percent of their needles.

Examination during the last week of the following May indicated a good burn was obtained on this tract. The aerial portions of 99 percent of the hardwoods were killed back to the ground. Nearly all of these trees were less than 4 inches d. b. h. Sprouts were visible on 55 percent of the stumps, with indications that more stumps would put forth sprouts (table 1).

TABLE 1.—*Stand table per acre for four tracts 7 months after burning*

Tree species and condition	Trees per acre on—			
	Tract 1	Tract 2	Tract 3	Tract 4
Pine:	*Number*	*Number*	*Number*	*Number*
Alive	100	130	88	0
Dead	425	22	100	0
Hardwood:				
Aerial portion alive	25	2,554	75	25
Aerial portion dead:				
Sprouting	1,700	2,772	3,100	2,237
Not sprouting	1,400	109	338	263

Company records indicate that during the first 3 months after burning, loblolly pine seeds fell on tract 1 at the rate of 205,000 per acre. Subsequent examination disclosed an average of 15,775 seedlings per acre in the cotyledon stage of development. Most of the tract was an open pine type that averaged 18,469 seedlings per acre. A stand of 6- to 10-inch d. b. h. oak trees on the remainder of the burned area did not drop their leaves until after the fire. These leaves covered nearly all of the surface. Only 5,000 seedlings per acre were present on this portion of the tract, although the distribution of seed trees was similar to that on the pine type. Stocking percentage for tract 1 was 100, as determined by percentage of milacre plots containing one or more seedlings.

[1] According to the Coastal Plain system of measurement rating fire danger on a scale of 1 to 5. It must be emphasized that fire danger class as rated in this paper is an estimate based upon on-the-ground observations by U. S. Forest Service personnel, who gaged such local factors as days since last rain, stage of vegetation, fuel moisture, and wind velocity. Such estimates are far from recommended procedure, but they were the best available.

Tract 2

The second tract to be burned had been logged under a strip clear-cutting method the previous spring. It was designed to burn this tract in early fall in order to take full advantage of the expected seed crop. Several abortive attempts at burning were made on days with a danger rating of 1 and 2. The job was not completed until October 25 when a wind of 8 to 12 miles per hour, combined with a fuel moisture content of 9 percent, indicated a class 3 fire day, which furnished the necessary impetus to spread the fire from one brush pile to another. The final burn on October 25, of approximately 30 acres, was accomplished by three men.

A clean burn was secured where the brush piles occurred. Most of the area between the piles was only lightly singed. In the burned area, hardwood stems up to 4 inches d. b. h. were killed. The average kill for the entire tract, including the unburned spots, was only 53 percent. Eight months later 96 percent of these trees had sprouted. The average for the tract is shown in table 1. A marked contrast was noted between the tract 2 kill on class 1–2 days and that on all tracts for class 3 days. On class 1 and 2 days almost no hardwood stems bigger than 1 inch in diameter were killed back. On a per acre basis only 27 of 152 pines 1 inch or less in diameter were killed by this light fire. However, on class 3 days more than 98 percent of the hardwood stems under 4 inches in diameter were killed back, as well as 92 percent of pine this size.

In large slash piles on tract 2, fuel up to 2 inches in diameter was consumed. The duff [2] was not completely consumed, even under the slash piles. The percentage consumed is shown in table 2.

Seed talley on this tract showed 127,440 per acre. A cutting test disclosed that 67 percent of the seeds were sound. A midsummer 1947 inspection indicated an average of 4,408 seedlings per acre. The seedlings with the best development and most vigorous appearance were found in the burned areas. Over twice as many seedlings germinated in the skid trails and jammer sets, but when germination occurred on bare soil, the seedlings were small and of poor color. The best germination occurred in skid trails having a ground cover of grass and weeds. Every milacre plot that fell in a skid trail or jammer set contained from 1 to 27 seedlings. No seedlings were found in 3 percent of the plots occurring on the burned area. In the unburned areas, 20 percent of the milacre plots did not have any seedlings. Number of seedlings by surface soil condition types is shown for tract 2 as follows:

Surface condition:	*Seedlings per acre*
Unburned	2,342
Burned	3,928
Skid trails and jammer sets	8,171
Average all conditions	4,408

The tract as a whole showed 93 percent stocking.

[2] The term "duff" is used here to denote all the natural accumulation of leaves and twigs above the surface of the soil.

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Tract 3

This was a 30-acre forest-grown loblolly pine tract cut over in 1943 leaving 6 to 8 seed trees per acre. The ground on this 3-year-old slashing was covered with a dense growth of low shrubs, vines, and broom sedge, interspersed with hardwood sprouts 6 to 10 feet high. This area was burned on the same afternoon as tract 2. Wind velocity was 8 to 10 miles per hour, gusty; fuel moisture 9 percent; fire danger estimated as class 3. A well prepared fire line and good burning conditions enabled 16 men to burn this 30-acre tract in 3 hours.

TABLE 2.—*Duff consumed by fire on tract 2*

Kind of duff	Depth		Amount burned
	Before fire	After fire	
	Inches	*Inch*	*Percent*
Pine	2. 9	0. 8	72
Pine-hardwood	2. 5	. 5	80
Hardwood	2. 0	. 4	80

Here again, concentrations of brush in piles limited the effectiveness of the burn. Where the fire ran freely before the wind, an effective burn was obtained. In fact, the fire was so hot that a few residual pines 80 feet in height lost their crowns, although there was little or no slash near the base to cause damage to the tree trunks. Where fire was burning against the wind, it damaged only a few of the shrubs that occurred between the brush piles.

Subsequent tally indicated that 98 percent of the hardwoods were killed back to the ground. Sprouts occurred on 90 percent of these trees (table 1). Five percent of the seed trees lost a large portion of their needles but no dead trees were observed during the reexamination.

No estimate of the 1946 seed supply was made. It may have been relatively small because this was a diameter limit cutting leaving only 1 or 3 seed trees per acre. The 1947 inspection indicated 2,225 poorly distributed seedlings per acre and 68 percent stocking.

Tract 4

This 56-acre tract had been clear cut about 2 months before the burning took place preparatory to planting. All pine and hardwood trees over 4 inches d. b. h. were harvested. The interesting feature in this case was that the slash was scattered uniformly over the tract, a direct result of this company's method of logging. Eighty to ninety percent of the surface area was covered with slash to a depth of 3 to 6 feet. Seven men burned this tract in about 6 hours on an estimated class 3 day in early November.

Although the fire burned readily, the slash was not reduced to the extent desired, because of its green condition. Most of the twigs under one-half inch in diameter were consumed, but branches over 1

inch in diameter were not. The hardwoods were satisfactorily killed back to the ground. Only 1 percent produced new leaves in the crowns in 1947. Sprouting occurred on 89 percent of the fire-injured trees (table 1). The tract was planted in the spring of 1947 as no seed source remained after the clear cut.

CONCLUSIONS

More trials are needed to determine the value of prescribed burning as a silvicultural tool. The four attempts discussed in this paper are only mentioned in an effort to obtain a better understanding of the possible use of fire. Some of the conclusions, even though well known to fire control men, will bear repeating.

Good fire lines and careful planning are prerequisites to successful burning. The extra charges for fighting breakovers, having extra laborers present, and depending upon poorly constructed fire lines serve to emphasize this point.

For the season and region involved, conditions that combine to make a class 3 danger rating are required to develop a fire that will spread readily in cut-over slash area.

On days having a class 3 danger rating crowns of seed trees may be badly injured by flare-ups. It is important to move brush piles away from seed trees.

Burning on class 1 and 2 days killed the aerial portions of only one-half of the small hardwoods. On class 3 days over 98 percent of the hardwoods under 4 inches in diameter at breast height were killed back to the ground. Seedlings that germinate during the following growing season are thus given a better opportunity to become established.

Burning on class 3 days did not give a "clean" burn in the sense of consuming hardwood saplings, or slash, or duff to expose mineral soil. The fire consumed most of the limbs up to 2 inches in diameter in slash that had seasoned for 6 to 8 months. Branches over 1 inch in diameter did not burn readily in slash that was only 2 months old.

The total cost chargeable to prescribed burning was relatively high because of the safety and protective measures required.

A good initial catch of seedlings was secured when an ample supply of seed was available.

The reduction of hardwood competition will be of short duration because a large portion of the injured hardwoods sprouted during the first growing season following the fire.

PORTABLE HOSE COUPLING EXPANDER

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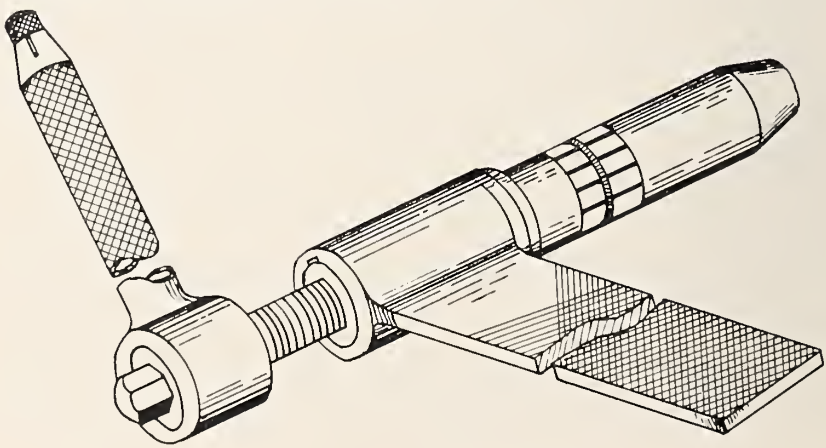
A portable tool has been devised for replacing hose couplings in the field on Forest Service standard 1½-inch hose. The tool is a small compact unit stored in a case, 4 by 5 by 14 inches and easily assembled in a few seconds. It is a radial ferrule expanding device, so constructed that it can be held with the foot, similar to holding a pipe with a stilson wrench on the floor.

The coupling on the piece of hose to be discarded is removed by driving a chisel, or tool of similar nature, between the coupling and the expanded ring and prying the ring out. A ferrule is slipped over the segments of the expander. A slight shoulder about the thickness of the ferrule stops it from going beyond the segments. The hose is then inserted into the coupling, and shoved over the end of the expander until the coupling hits the stop, which sets the expander ring in the right spot. Stops are provided for both male and female couplings on the same head. If a rubber gasket is used, put it in ahead of the hose in the coupling. When the hose with the coupling and expander ring are on the device ready for the expansion of the ring, slip the foot vise over the key, put the arch of the foot over the round part of the foot vise with the toe over the knurled wing, slip the rachet on and expand the ring. When the ring is on, turn the rachet lock, run the rachet backward a stroke or two to relieve the expanding segments, remove rachet and unscrew with fingers until tool can be removed. The operation takes only a few minutes and saves delay in replacement of hose on a fire.



THE DISK-DOZER

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Equipment Development Report No. 9, December 17, 1946, described a clearing and trenching implement designed and constructed at the Portland, Oreg., Equipment Laboratory and Shop for attachment to the Beetle Tractor.[1] This implement was aptly named the disk-dozer by the late David P. Godwin. It showed such good possibilities for fire control line clearing and trenching that three similar disk-dozers were constructed at the Portland Shop for trial in other regions, and a larger one for trial in the North Pacific Region with the new Oliver HG tractor, for which orders had been placed by several regions. This tractor, with bulldozer, weighs 4,840 pounds. Because of delay in delivery of the tractors, the larger disk-dozer could not be tested until the fall of 1947.

As shown in figure 1, the disk-dozer consists of two rolling disks, mounted at right angles, and a combination cutting coulter, log pusher horn, small middle breaker, and wings to protect the disks, the whole, assembly being mounted on channel steel for attachment to the A-frame of the tractor in place of the bulldozer blade and its arms. The change from bulldozer to disk-dozer can be made in a few minutes.

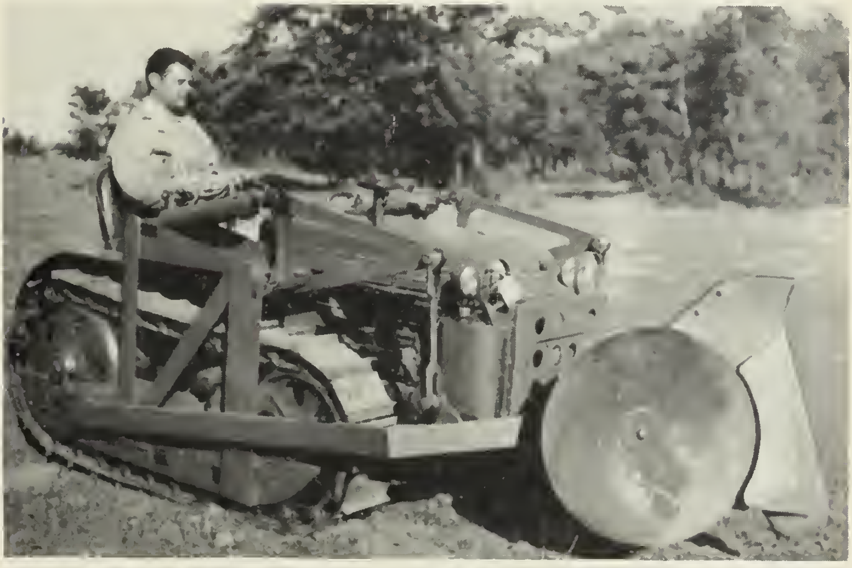

Figure 1.—Oliver HG tractor and disk-dozer.

[1] Fire Control Notes, July 1946. The latest model tractor weighs 2,200 pounds, is 33½ inches wide, and has 6-inch track plates. Speeds are somewhat lower.

The Beetle size unit has 22-inch disks and weighs 145 pounds. The larger size has 28-inch disks and weighs 390 pounds. The respective weights of the bulldozers on the two tractors are 125 and 345 pounds. It appears practicable and desirable to reduce the weight of the larger disk-dozer to less than that of the bulldozer blade which it replaces.

Tests so far made with the small disk-dozer in the North Pacific Region have indicated that, even without changes, it is better than a pull plow for use with the Beetle tractor. The first tests of the larger unit showed certain disadvantages, which it appeared might be overcome by further study and experimenting. It continuing the tests it was considered desirable to construct parallel lines with an Oliver tractor and disk-dozer and another tractor with bulldozer and Wescoatt plow.[2]

The preliminary tests were made on the east side of the Mount Hood National Forest in September, before the heavy fall rains. The soil, a heavy clay loam with considerable rock, was very dry in the open but somewhat moist under heavy cover. The tractor, with disk-dozer raised, was driven up a 50 percent south slope, having a cover of grass and weeds with occasional clumps of brush; then a trench was plowed down the slope. This operation was entirely satisfactory.

FIGURE 2.—One-disk trench along a 50-percent slope.

[2] E. D. Report No. 1.

One disk was then removed and a trench was plowed parallel with the slope (fig. 2). An excellent cupped trench was made, and the soil thrown on the downhill side lowered the grade under the tractor 4 percent.

On a north slope in ponderosa pine reproduction and brush, with quite a bit of down material and rock, the going was tough. The disks took considerable punishment without damage. Approximately 15 chains of line were constructed around an area at the rate of 38 chains per hour. The disk-dozer proved to be very effective for clearing away all kinds of ground cover, and it made an acceptable trench.

The comparative disk-dozer and plow tests were made in October on the Ochoco National Forest, on a north slope covered with a mixture of Douglas-fir, western larch, lodgepole pine, and ponderosa pine, and on more or less open ground in ponderosa pine. Reproduction was thick along more than half of the lines. The soil varied from clay loam to sandy loam, and from very rocky to little or no rock. While light rains had occurred, local men thought the implements would have made as good trench in this location at the height of the dry season, except that the roll would have been somewhat less.

Parallel lines about 20 feet apart were constructed with the two outfits, up over a hill then around and down to the point of beginning, a total distance of 96 chains. Except for one chain of 55 percent slope, where trenching was done straight down, slopes varied from 7 to 37 percent, uphill, and from 10 to 20 percent, downhill, with 31 chains approximately level and 3 chains along contour. Logs and debris were estimated as light for 57.5 chains, medium for 25.5 chains, and heavy for 13 chains.

Both outfits completed the lines in 2 hours, 5 minutes, or at the rate of 46 chains per hour. The disk-dozer went faster in thick cover and where there were logs, but the plow caught up in the open. The tractor with disk-dozer was in low gear (1.45 m. p. h.) all the way, while the other tractor was in second gear (2.30 m. p. h.) part of the time in the open.

As in the preliminary tests, the disk-dozer was especially effective for clearing away logs and other down material. The sharp coulter was much better than the bulldozer for breaking and moving logs, and hydraulic control of the implement facilitated the removal of heavy duff and rotten material. In backing, which had to be done frequently in heavy clearing, the advantage of having nothing behind the tractor was outstanding. It would, no doubt, have been more so if the tractor were equipped with a reversing clutch, as the Beetle and Clarkair are. The necessity for shifting gears reduces clearing speed with the disk-dozer relatively more than with the bulldozer and plow, because the plow interferes with backing even when a reversing clutch is used.

The bulldozer blade, used in angle position, had a tendency to "hang up" on logs and trees, and in backing the plow jack-knifed and at times interfered with turning movements of the tractor. Also, in heavy clearing where the full power of the tractor was needed for that operation, part of it was taken by the plow at times when that implement was doing no effective work but only digging deeper with every forward surge of the machine. This could be overcome to a large extent by controlling the plow hydraulically, but the lifted plow

would still interfere with backing and would be a dead weight on the rear end of the tractor.

The disk-dozer went between small trees and laid them over to either side of the line, while the bulldozer laid most of them ahead. When the disk-dozer rode over the reproduction and brush, it was necessary to back up and get under them with the disks to root them out. The plow outfit had the advantage in this respect, because the disk-dozer operator, while thoroughly experienced with bulldozers, had never practiced with the disk-dozer.

Both outfits made good trench, the disk-dozer trench averaging about 7 feet, including roll, or about 40 percent wider than the plow trench on the level (fig. 3). Width of trench, under North Pacific Region conditions, might well be sacrificed to save power and gain speed. Neither implement appeared to have the advantage in rocky soil. The rocks did not materially damage the disks, which are standard farm disks and, therefore, replaceable at small cost.

FIGURE 3.—Trenches made with Westcoatt plow (left) and disk-dozer (right).

One disk only was used on the steeper side slopes and for a short distance on level ground. The time for removal and replacement of the other disk was counted in the total time. Some practicable means of carrying the idle disk on the tractor will need to be devised. The one-disk trench was very good. On the level, in addition to less power consumption, there was the advantage of throwing no soil or debris to the "fire" side. However, the use of only one disk on the level is not practicable without some method of compensating for side thrust.

In all tests with the disk-dozer, the operator found it very difficult to control depth of trench. Working the hydraulic control almost constantly, even where there was no clearing to do, he could scarcely

keep the implement at a constant depth, because it usually went in or came out too far before the action could be reversed. It seems likely that this disadvantage can be overcome by installing depth shoes on the disk-dozer frame back of and outside the disks. With effective depth shoes, the operator should be able to maintain uniform depth with down pressure on the implement.

The tractor with disk-dozer loads to better advantage than the tractor with plow. The former is backed into a standard 1½-ton truck, with the coulter just ahead of the endgate, giving excellent load distribution. The latter must be loaded with bulldozer forward and the plow overhanging, with the endgate removed, so that the weight is too far to the rear. However, both outfits were handled nicely in 1½-ton trucks, though there was an overload.

After considering the results of the tests, further development work on the disk-dozer for the Oliver HG tractor was recommended. Improvements found desirable would, of course, be incorporated in other sizes that might be constructed. The following development work is proposed:

1. Install depth shoes, quickly adjustable, to overcome wavy trench profile and to maintain uniform depth.
2. Try smaller disks, which will make narrower trench and thus save power and increase speed in light cover. Use new super-alloy disks.
3. Decrease depth of coulter and middle breaker to save power. Decrease thickness of this part of the implement. The pilot model is overly strong.
4. Experiment on level ground with one disk only and a long finned coulter as a means of overcoming side thrust.

Experience with the disk-dozer so far indicates that improvements to increase speed and make trench of uniform depth can be worked out and that, after this has been done, it will be much better than a bulldozer-plow combination for the clearing and trenching job under most conditions in the North Pacific Region. However, in areas with light cover and little or no rock, greater speed can probably be made with a drawn plow.

Suggestion to Facilitate Fire Sign Posting.—The suggestion in Fire Control Notes of October 1947, page 27, about how to fasten fire posters to backs brought out the following suggestion from a Region 4 forest supervisor.

Use four cupped brass washers, over-all diameter ¾-inch, with ¾-inch No. 6 brass round-head screws to fasten a 9- by 11-inch poster to the birdhouse back. Place bottom washers under poster at corners, and top washers at sides just below corners. Drill holes for screws.

The advantage of this system is that after the screws and washers are once in place all one has to do to replace signs is to loosen screws, remove old posters, insert new posters, and tighten screws. The only tool required is a small screw driver and there is no hammering or marring sign back. For the 14- by 22-inch birdhouse backs two additional washers are used at the middle of the sign.—DIVISION OF FIRE CONTROL, *Region 4, U. S. Forest Service.*

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CONSOLIDATED FIRE ORGANIZATION CHART AND DISPATCHER'S BOARD

Fred G. Ames

District Ranger, De Soto National Forest, Mississippi

The combined fire organization chart and dispatching board in use on the Chickasawhay District of the Mississippi National Forests has been developed to a higher degree than is normally found. This district has had as many as 35 incendiary fires with one to scores of sets each within a 12-hour period and 254 fires in a 2-month period. Through use of the combination board and the dispatcher's individual fire record described below, the dispatcher has been able to keep abreast of each situation as it develops.

This consolidated board was developed to assist the dispatcher in keeping up with developments so that at a glance he can determine the organization and other facilities on the district available for fire duty.

The features of the consolidated board, as indicated by corresponding numbers on the diagram, are—

1. *Detection chart.*—Contains the name of each tower together with the name of the regular lookout, the name of the alternate lookout, and the tower manning schedule for that particular tower. In addition are the brief plans for emergency patrol and airplane use.

2. *Organization.*—The district organization is posted on index cards inverted and held in place by cupboard hooks to facilitate raising the cards to locate desired information. This portion of the dispatching board contains seven cards appropriately labeled: District Officers, Non-District Officers, Law Enforcement, Special Men, Food Supply, Other Supplies, and Special Equipment.

3. *Fire crew placement guide.*—A guide for the placement of all types of fire crews during the fire season, based on fire danger class ratings, lists the mechanized fire crew headquarters, the placement of Forest Service labor crews, and assignment of work projects that may be carried on along with the fire duty. The guide provides for week ends and holidays as well as work days, and also brief information on assignment of cooperator crews.

4. *Map of district* (*small scale*).—The dispatcher keeps locations of all crews available for call by use of numbered pins, the numbers corresponding with the crew numbers assigned as mentioned under 10, 11, and 12. (A red pin is used to denote a going fire and the individual crew pins are moved to the fire location as the crews are dispatched to that fire.)

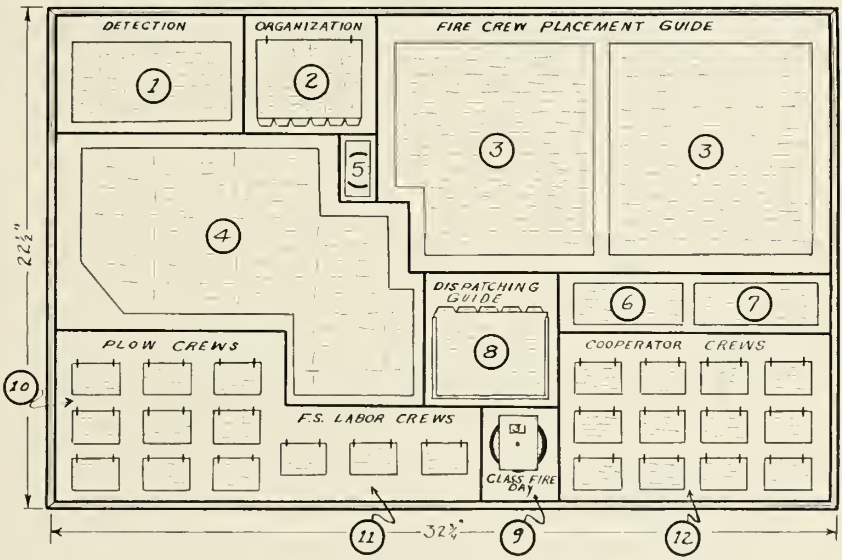
5. A small card consisting of a list of the elements necessary for a fire crew boss to know about a fire at the time he is dispatched to the fire—memory refresher for the dispatcher.

6. A small card listing conditions or occurrence of events which must be reported to the ranger by the dispatcher.

7. A small card listing conditions or occurrence of events which must be reported to the supervisor's office by the dispatcher.

8. *Dispatching guide.*—Provides information on the minimum manpower and equipment requirements for a going fire, based on the class of fire day. This information is posted on index cards appropriately labeled, one card for each class of fire day. The cards are held within slots so that the minimum dispatching requirements for the particular class of fire day can be placed in front for ready reference.

9. *Fire day class.*—A rotary chart on which the current fire day class is shown and which is the basis for organizational adjustments necessary for compliance with 3 and 8 above.



Chickasawhay Dispatching Board.

10. *Plow crews.*—Each plow crew is assigned a number and pertinent information concerning the plow crew is posted on small cards (1½ by 2 inches). The information posted on the cards is the crew number, crew base location, foreman, number of men, transportation facilities, tool cache, communication facilities, and food supply. The cards are hung on small cupboard hooks. As a crew drops out of the organization the card is turned back up.

11. *Forest Service labor crews.*—Posted and mounted similar to the cards for plow crews.

12. *Cooperator crews.*—Posted and mounted similar to the cards for plow crews.

An integral part of this concise, fast-moving fire organization plan is the Dispatcher's Individual Fire Record, which has been effectively used on the Chickasawhay District to reduce the time required by the dispatcher to record the events in connection with a fire. The form insures a more complete and concise record of events than would otherwise be possible, and with less effort on the part of the dispatcher. This is desirable on districts that often have several going fires at one time.

All information concerning detection, location of fire, and initial dispatch is recorded with relatively little writing.

This form greatly facilitates the review of action on fires. All information gathered by the dispatcher pertaining to one fire is recorded on a single letter size sheet. It is placed in a ring binder along with

This form greatly facilitates the review of action on fires. All in-curring on which action is taken are recorded on the dispatcher's individual fire record, and all other types of events are recorded on the log and diary sheets. From time to time the sheets of both forms are removed, checked for chronological order, and bound for filing.

Another aid to the dispatcher is a set of aerial photographs indexed by townships and ranges with section lines marked thereon. These are conveniently filed by the dispatcher's desk so that at a glance he can tell what type and density of fuel and timber is involved and also can determine from this bird's-eye view if there are any roads or natural breaks which might not have been shown on the map.

-DISPATCHER'S INDIVIDUAL FIRE RECORD-

-DETECTION-

Sta.	Azmi.	Hour	Min.	A/P
Wau.	149	2	16	P
F.T.				
T.C.				
P.W.	252	2	18	P
Ston.				
B.C.				

Twp. 6
Rge. 8
Sec. 31

Date 3/16/47
Fire No. 147
Name Plantation

-INITIAL DISPATCH RECORD-

Name	Location	Time	A/P	Crews Plow	Crews Labor	No. Men
Coleman	Mulberry	2:19	P	✓		5
Landrum	Wausau	2:21	P	✓		5
Jones	P.W.	2:23	P		✓	8

MESSAGE To	From	Station	Time	A/P	DIGEST OF CONVERSATION
Ranger		Laurel	2:24	P	Reported fire - Is leaving for fire
	Hyatt	P.W.	2:25	P	Reports fire spreading fast
	Coleman		2:57	P	Arr fire - Can handle fire alone
Landrum		Route	2:58	P	Ordered to return to Wausau
	Bradley	Wausau	3:14	P	Reports fire apparently under control
	Ranger	Fire	3:15	P	Arr. fire
	Coleman	Fire	3:22	P	Fire under control 3:19 P
	Jones	Fire	3:26	P	Arr. fire - mop up
	Coleman	Fire	3:34	P	Fire mopped up + out. Ordered him to
					return to Mulberry + ordered Jones
					to return to P.W.
	Ranger	Fire	3:35	P	Leaving fire

Dispatcher's Individual Fire Record.

FIRE DAMAGE APPRAISAL

J. A. Mitchell

Silviculturist, Lake States Forest Experiment Station, U. S. Forest Service

Fire damage appraisal is an involved and controversial subject. There is need, however, for a common policy in regard to damage appraisals for statistical purposes, if damage statistics are to be consistent and are to have historical and administrative value.

Unfortunately, forest fire damage is not an absolute quantity that can be precisely determined, since it involves certain more or less arbitrary assumptions and premises that must be established by agreement. Nor is any final settlement of the damage appraisal problem possible, since basic conditions as well as our conception of what constitutes damage are subject to change. The most that can be hoped for is agreement on a procedure that will serve current needs and give consistent and generally acceptable results. The last is important for, if damage estimates are not generally recognized as sound and reasonable, they carry little weight and tend to discredit fire control effort.

The legal basis for damages is the difference in value of the property involved before and after injury is sustained. Since the injured party is entitled to the continued undisturbed enjoyment of his property, however, his loss is not limited to the value of the part actually destroyed but to the depreciation in value of the property as a whole. Thus damage may properly include a reasonable valuation of any recognized benefits or values which may have been destroyed.

Forest fire damage, for example, may include not only the value of merchantable timber and young growth destroyed but also numerous direct, indirect, and intangible losses. The more important of these are:

- Forest damage:
  - Merchantable timber loss.
  - Young growth loss.
  - Damage to stand left.
- Other direct losses:
  - Grazing and wildlife values.
  - Productive capacity of the land.
  - Forest products.
  - Improvements.
- Other direct losses—Continued
  - Equipment, personal property, etc.
  - Suppression costs.
- Intangible losses:
  - Watershed values.
  - Economic values.
  - Social values.
  - Speculative and sentimental values.

Which of these items should be considered depends on the purpose for which the damage estimate is desired. A timberland owner, for example, suffers a direct financial loss represented by the tangible timber and property values destroyed, but is not directly concerned with such intangibles as watershed or social values. The public, on the other hand, suffers no direct property loss but is concerned with the loss of watershed, economic, and social values. Again, an indi-

vidual who has acquired timberland for exploitation is concerned only with the merchantable values destroyed. But, if the property was bought as an investment, he may also suffer a loss of potential values. On the other hand, if the property is being managed for timber production, damage may be measured by the reduction in income or yield due to the fire. From the standpoint of statistics or fire control administration, both tangible and intangible losses may properly be considered.

The validity of all of the above items of loss is recognized. It is proposed, however, to confine the present discussion to ways and means of evaluating direct damage to merchantable timber and young growth. To further focus the discussion, it is also proposed to consider damage appraisal from the standpoint of fire statistics rather than that of compensation for damages. While the two might be the same, the latter calls for the specific loss in a particular case, whereas the former calls for an average figure generally applicable to similar stands.

There are three concepts on which damage can be based: (1) Market or sale value, (2) present worth or expectation value, and (3) cost or replacement values.

Depreciation in market or sale value is the most direct measure of tangible loss, and underlies all other methods of damage appraisal since, in the final analysis, marketability is the basis of value. Damage to merchantable timber is usually figured on this basis. It presumes, however, a demand for the property in question at a price fair to both buyer and seller.

Expectation value is the usual basis of appraisal in the case of inaccessible or immature timber for which there is no current demand. This calls for discounting the recognized future value of the property to its present value as an investment.

Cost or replacement values as a measure of damage have the advantage of being relatively simple to figure, but they are the least sound since they ignore the real value or intrinsic worth of the property. While sometimes used as a basis for compensation, neither cost nor replacement value can be justified as a measure of damage if they exceed the market or reasonable present worth of the property in question.

There is no question as to the applicability of market value as the basis of valuation in the case of mature timber. If, however, the timber involved is not mature, two questions of policy arise. First, should future increment be considered; second, should present or estimated future stumpage prices be used in computing loss?

The answers depend on whether the stand under consideration was to have been cut or was being held as an investment. If it would have been cut in the near future, current market value should be used. If, however, it was being held as an investment, a reasonable increase in volume and possibly quality might justifiably be considered. The use of anticipated future stumpage prices, however, is open to question, since the values resulting are purely speculative.

If the value of a stand at maturity is accepted as the basis of value for immature stands, the simplest way of determining present worth is to multiply the mean annual value increment by the age of the stand when destroyed. This amounts to simple interest on the bare land

value at a rate which will give the predetermined maturity value in the specified number of years. This method, however, gives intermediate values higher than the actual market value at all points short of maturity.

A second method is to discount minimum merchantable value at compound interest to the age at which the stand is destroyed. The difficulty here is to determine the discount rate to be used. If the rate used is low, the initial and intermediate values derived may be too high. If high, the initial and intermediate values may be too low. From a strictly financial angle, the discount rate would be determined by the rate prevailing in the case of investments of equal desirability.

Another method is to use an agreed upon initial value. This automatically determines the discount rate but leaves the initial value to be used open to argument. It also results in varying discount rates, since the rate will change with any change in initial value, time interval, or maturity value.

As to the initial value that should be used, there are several schools of thought. One argues that it should be zero in all cases since we are dealing primarily with natural unmanaged stands, which have involved no outlay for establishment. Another argues that the average cost of planting should be used, since reproduction does not necessarily follow fire or may be slow in coming in. Others favor using planting cost where plantations are involved or artificial reforestation is likely to be necessary. The use of planting cost, however, assumes that the land is being held for timber production. It also introduces the third method of damage appraisal, i. e., cost or replacement values.

While cost and replacement values have much in common, they involve two distinctly different ideas. The proponents of cost value argue that the landowner is entitled to recapture his investment which may or may not include planting costs, but would include any actual expenditures plus interest.

Replacement value, on the other hand, ignores both actual cost and the real value of the property destroyed. The premise on which this method is based is that the cost of physical restoration is the proper measure of damage sustained. In this connection it might be pointed out that compensation for values lost, not physical replacement, is the legal basis of damage.

The policy laid down for the Forest Service by Greeley in 1925 called for determining damage on the basis of administrative and protection costs, plus compound interest at a rate determined by the expected maturity value of the stand at estimated future stumpage rates. Five dollars per acre was also added for planting where natural reproduction in a reasonable time was considered unlikely. This was all rather complicated to figure, but was reduced to tables based on site, type, and size class, for general use.

The present Lake States damage tables are based on the current average market value of 5- to 9-inch stands, discounted to the age when damaged at the rate of 5 percent. Theoretically at least, this represents the present value of immature stands as an investment. The method is simple and realistic, but admittedly conservative. Whether or not 5 percent is the proper discount rate to use may be

open to argument. The real question at issue, however, is whether real worth or cost of production is the proper basis of loss.

It is conceivable that the day will come when the market value of timber will be determined by its cost of production. At present, however, the two have no relation. Since any excess of cost over realizable value is an investment loss that would be suffered whether the timber was destroyed or not, it hardly seems reasonable to charge this investment loss to fire. Looking at the matter realistically, therefore, the soundest basis for timber damage appraisal would appear to be the present worth of the timber as an investment.

A Helicopter in Fire Control.—After more than 25 years of fighting fire I feel that I have this summer witnessed a machine that is destined to play a more important role in fire suppression than any other one piece of fire equipment that we have at our command. This piece of equipment is the helicopter that was used on the Allen Ranch fire on the Eldorado and the Schuyler fire on the Mendocino.

I had the opportunity of riding in this machine on a reconnaissance flight and of observing some of its actions and performances under actual fire conditions.

On the Eldorado it was used as a scouting plane. From my own experience I actually saw more fire and fire-line conditions in 16 minutes of flight time than I could have seen by ground travel (foot and auto) in a full daylight day. I knew after this short flight just what I was up against as night fire boss. This information was not second hand when I got it; it was my own observation, and in addition I had a clear picture of the entire fire, roads, topography, and location of fire lines. To anyone going onto a fire in strange territory this is vital. Admittedly, maps and aerial photographs help a lot but to actually see the entire picture is the real pay-off. It places the fire boss in a position where he is much better prepared to analyze ground information that comes in from the lines and scouts.

On the Mendocino fire this same plane was used for scouting and transporting food to the lines. In one case the division boss (District Ranger St. John) scouted his division and then was set down almost in the middle of it. This saved him a lot of hard foot travel and, as he expressed it, a new pair of boots. Where St. John was set down was in one of the roughest parts of the fire.

To me the important features of the helicopter as applied to fire control are as follows:

1. It can fly low (treetop height) and slow. This gives the observer an ideal chance to see the ground conditions.
2. It can land most any place. On the Eldorado it landed on top of a lumber pile and in a small meadow. On the Mendocino it was landing on a wide spot in the road.
3. It can fly in and out of areas that would be impossible to get into with an airplane.

I feel that on a lightning forest like the Klamath a helicopter would pay its way in a very short time. Men could be put on, or near, small lightning fires within a few minutes of discovery. Now it takes 4 to 20 hours of hard travel on foot to get men in where the helicopter could do the job in a few minutes. On top of that fresh men would be on a small fire, not tired men on a much larger fire.

I feel that the time is not too far off when we will have centralized kitchens and the men on the line will be served hot meals, not the conventional nose bag.

By using a helicopter on patrol of larger fires many men could be eliminated. A helicopter, radio equipped, and in communication with a few men on the ground, could certainly direct a patrol job much better than we are doing now.

Many miles of fire roads and trails might be eliminated from our transportation system, thereby saving maintenance money that could be applied to better maintaining those roads and trails that we will have to have in our system.

Afer seeing this machine at work on two fires this year I am certainly sold on it, as are other northern men who have witnessed its work.—T. A. Bigelow, *Forest Engineer and Fire Control Officer, Klamath National Forest.*

MULTIPURPOSE TRACTOR-DRAWN TRAILER AND SLIP-ON PUMPER TANKER

R. A. MacIntyre[1] *and* George L. Bouck[2]

Region 5, U. S. Forest Service

Among the projects assigned in 1946 and 1947 to United States Forest Service Equipment Development Center, Arcadia, Calif., was the development of two tractor-drawn trailers. One was to be a lube and fuel service unit for tractors working on fire lines away from roads. The second was to be a tractor-drawn tanker trailer with pump. The first unit to be completed and field tested was a 1-ton capacity trailer with fuel and lube service equipment. This unit proved successful in "breakdown" tests, but when used on several large fires on Los Padres National Forest, the fuel capacity was found to be insufficient. As a result of this experience, field personnel recommended that the basic chassis design be retained, but the trailer be increased in size to accommodate six oil drums standing vertically and the fastenings or tie-downs be rearranged to suit general cargo hauling.

In view of these developments, it was decided that the lube and fuel service trailer and the tanker trailer be combined as a tractor-drawn utility trailer, as recommended, and that it be supplemented by a slip-on pumper-tanker unit to produce the tractor-drawn tanker trailer.

UTILITY TRAILER

The completed trailer has been constructed with a pay-load capacity of 1½ tons and the ability to travel fire line behind D–6 or larger tractor regardless of ruggedness of terrain or soil conditions. It also is capable of being drawn by vehicles other than tractors and can operate as a tractor fuel and lube unit transport, a slip-on pumper-tanker transport, or a utility supply trailer for any special purpose desired.

To meet the requirement of travel over rough terrain, the trailer body was constructed in the form of a stone boat (fig. 1, top). Sides are of 10- by 2⅝-inch channel iron. Front, bottom, and rear are of ¼-inch steel plate. The tongue, a 4 by 6 box beam, is of sufficient length to allow jackknifing of the trailer and tractor to 90 degrees. Principal dimensions are as follows: Over-all length 13 feet 2 inches, over-all width 7 feet 6½ inches, body length 7 feet 9½ inches, body width 4 feet 5¼ inches. Weight empty is 1,723 pounds. The trailer has Ford dual wheels with 8-ply 7.00 x 20 tires.

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[1] Mechanical Engineer, Arcadia Fire Control Equipment Development Center.
[2] Area Superintendent, Equipment Service, Stockton Equipment Depot.

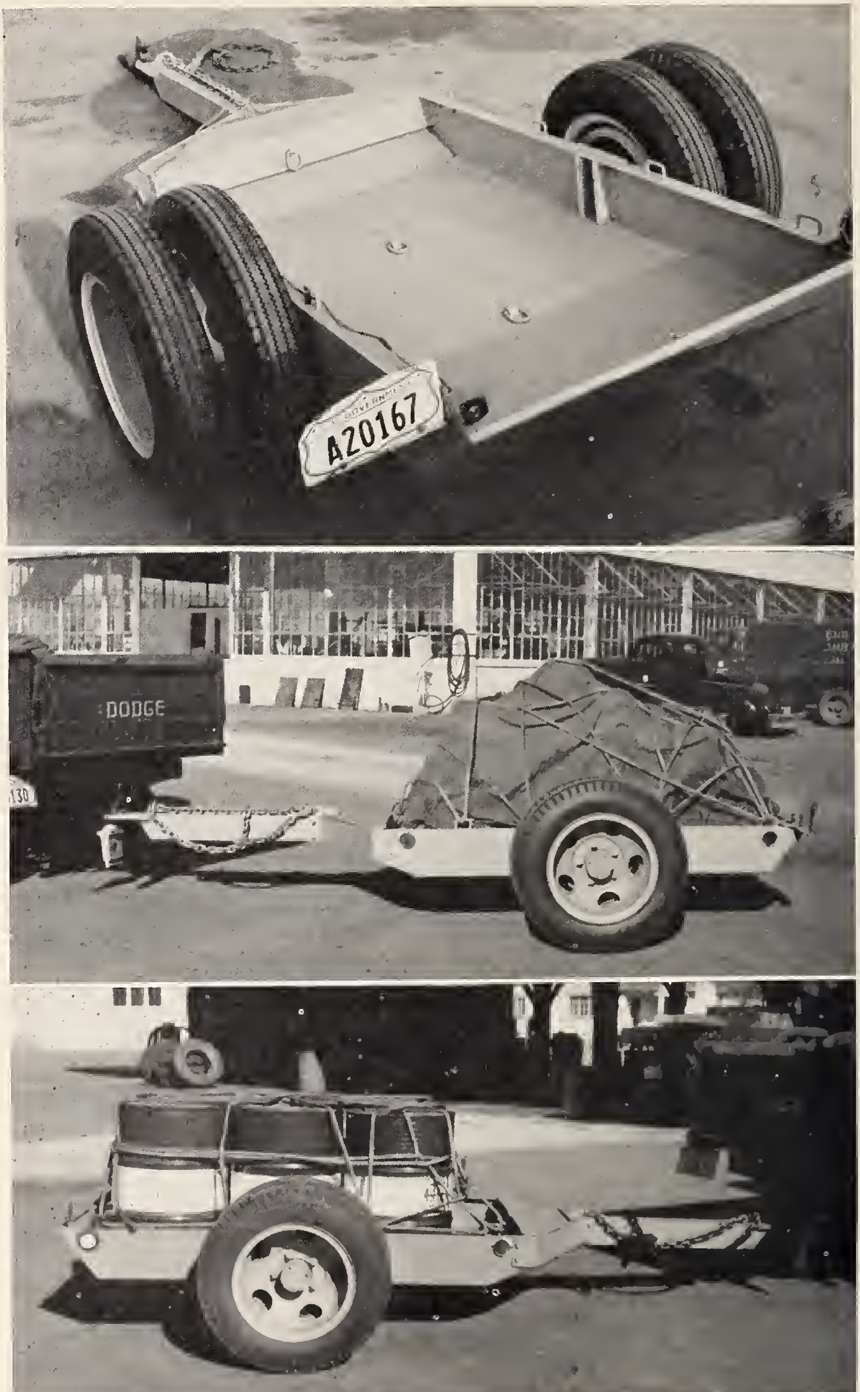


FIGURE 1.—Tractor-drawn utility trailer: Empty, with general cargo, and with load of fuel (barrels may also be carried on their sides).

Load tests and operation under actual fire line conditions at several large fires during the 1947 season have demonstrated that this trailer will follow wherever the pulling tractor can go. Hitched to a D–6, the trailer encountered no difficulty regardless of whether the wheels were mired and it was sledding along or whether it was being dragged over rocks, stumps, logs, or ditches with one or both wheels off the ground.

License plate and tail light bracket has been made detachable so that it can be removed when the trailer is operating in brush or under conditions where the bracket might be broken. The angle formed by reinforcements of the tongue has been boxed in and a hinged cover installed. This provides a storage space for tire tools, jack, lashing chains, rope, etc. Sufficient tie-downs are provided to allow for securing any type of cargo that might be put on the trailer (fig. 1).

Since the unit is primarily tractor drawn, no brakes have been installed. The tractor conforms, however, to all California State High way Vehicle Code requirements. For road work the unit has been towed behind a 1½-ton truck, but because it has no trailer brakes the use of a larger towing truck is recommended when the trailer is loaded.

Plans have been prepared, although construction has not been completed, for a slip-on convoy luber and fuel unit to fit this trailer. This luber will consist of a gas-engine-driven compressor and tank, two pressure lubrication pots, one drum of water, and four drums of fuel.

SLIP-ON PUMPER TANKER

A 400-gallon coffin-type tank is used for the skid-mounted slip-on pumper tanker (fig. 2). Tanks for such units are painted aluminum, since they are often used for hauling and storing drinking water, and it is desired that the water be kept as cool as possible if the tanks are exposed to direct rays of the sun. The hose basket on top of the tank will accommodate 1,000 feet of 1½-inch single cotton-jacket rubber-lined hose and 16 feet of 1½-inch suction hose. The tank suction pipe terminates at the suction manifold at the right center of the tank front. A 5-gallon pack-type gasoline tank is mounted to the left of the suction manifold and on top of the accessory box. The portable-type pumper unit mounts on a universal bracket to the left of the gasoline tank. Suction side of the pumper connects to the suction manifold through a short length of 1½-inch rubber hose. A relief valve is mounted on the discharge side of the pumper and its relief port discharge is returned through the ½-inch rubber hose to the tank "return" connection at top center of tank.

With the 1½-inch gate valve on the suction manifold closed and suction hose connected to manifold, water can be drafted from overboard direct to fire or to tank. With cap on the suction manifold and the 1½-inch gate valve open, water can be pumped from the tank to fire.

The back-pack gasoline tank is fitted with a ¼-inch shut-off cock near the bottom and is connected to the carburetor intake through a short length of airplane-type gasoline hose. This tank is mounted at sufficient height to insure gravity feed of fuel to the pumper unit.

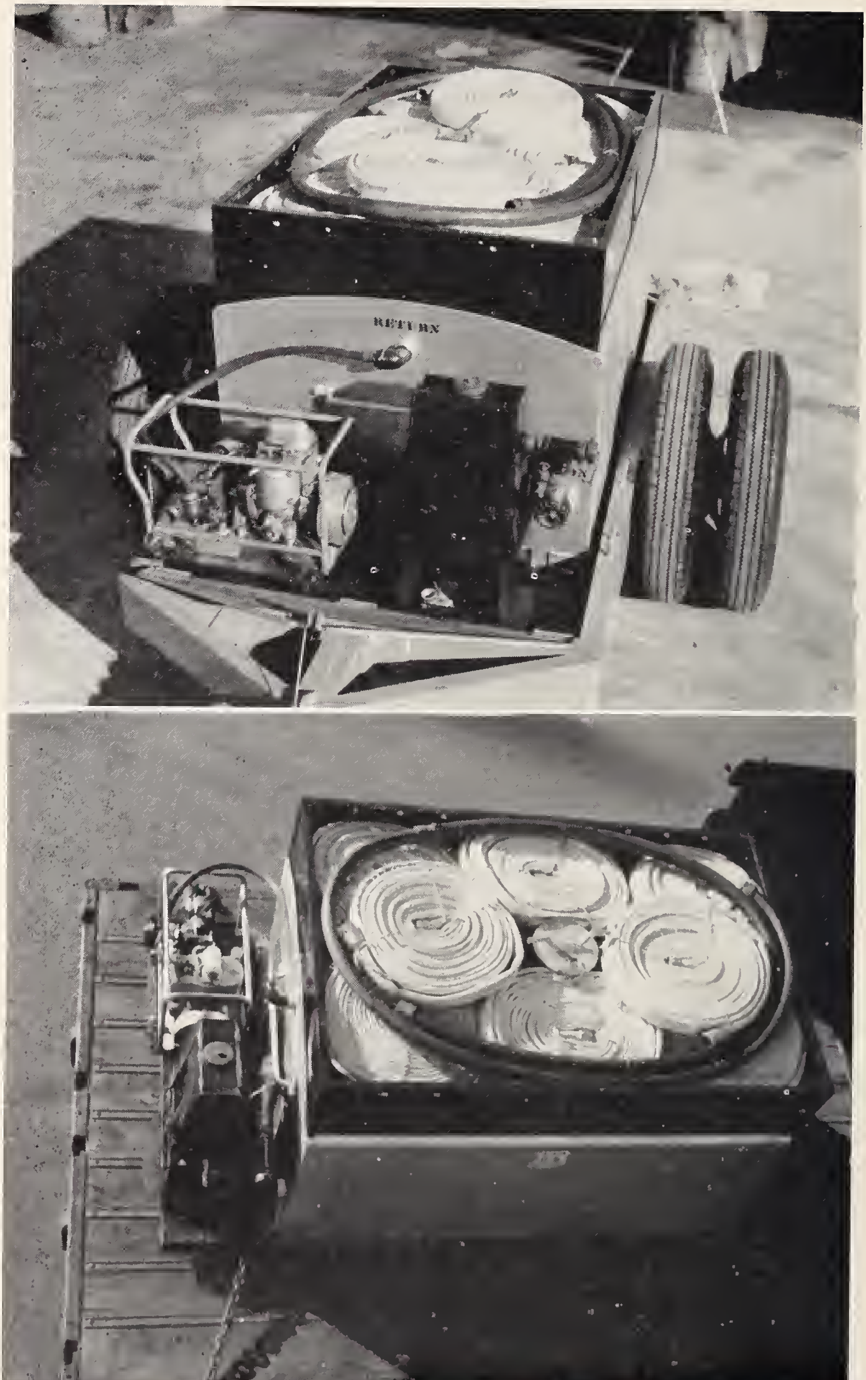


FIGURE 2.—Slip-on pumper tanker: Upper, mounted on a utility trailer; lower, mounted on 1½-ton stakeside truck.

The accessory box under the tank is used for the storage of repair tools, grease gun, nozzles, adapters, spanner wrench, etc., that are needed to make up a self-contained fire-fighting unit.

The bracket on which the pump is set has been designed for the quick mounting of the various portable pumpers in use by Region 5. This feature allows for the quick exchange of pumpers, if necessary, or for the removal of pumper for other uses while the tank is being used to haul water for other tankers.

Plans and detailed construction drawings are available and may be obtained for all of the above-described equipment from the Arcadia Fire Control Equipment Development Center, United States Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

Sound Economy on Fire Suppression.—During the past 35 years forest fire suppression has progressed from the day when a forest officer with a few men battled a large fire using a dry yucca stalk for a backfiring torch, often quite successfully, to the present day of fire fighting with the use of all modern equipment, bulldozers, flame throwers, radios, aircraft, rain-making devices, and, yes, 8-hour working days.

I can recall during the early years when we were brought to account and seriously criticized if suppression costs exceeded 50 cents per acre. Today the cost of fire suppression is staggering; it is true, of course, that labor, supplies, etc., all cost much more than 30 years ago.

The disturbing part is that with all the modern conveniences the output per man-hour, particularly where fire suppression requires hand labor, is pitifully small; also the fact that fires are still burning thousands of acres in spite of our many fire-fighting facilities. Numerous circulars, handbooks, and articles have been written covering all phases of fire suppression, job descriptions, individual instructions, organization, logistics, ad infinitum. Each of these seems to have produced more generals and less producers. Regardless of the purchasing power of the dollar, 60 minutes still make an hour. Don't we need to tighten our belts, produce more work and less manuals?

The old idea of 50 cents per acre for suppression was, of course, unsound. Nevertheless, the cost of fire control must be kept to a defensible and businesslike basis and consistent with the values protected. Neither must we be permitted to exaggerate the possibility as to where fires would spread if large expenditures had not been made.

Prompt and efficient initial attack may prevent a holocaust, but result in high cost for the area burned.

No one should question initial attack costs of fires within areas of high flammability, but when a fire escapes from a well organized initial attack force and is running wild is the time to do some careful planning for prompt control and mop-up after the lull which always follows, but no time to get excited and pour dollars into the caldron.

Let's take a realistic and cold-blooded analysis of suppression expenditures, particularly the output per man-hour, followed by an enforced policy of economy consistent with the actual values at stake.

Keep in mind FFF dollars are no different than the hard to get P and M and have to come out of the pockets of the taxpayer.—S. A. Nash-Boulden, *Forester, Region 5, U. S. Forest Service.*

THE COEUR D'ALENE AIR DETECTION PLAN

Ralph L. Hand

Forester, Division of Fire Control, Region 1, U. S. Forest Service

While the Coeur d'Alene Detection Plan evolved from the apparent success of aerial activity on the so-called Continental Area,[1] the two projects are actually as diverse as can well be imagined.

In order to appreciate the problems that confronted the planners in developing the Coeur d'Alene project, it seems desirable to briefly compare the two areas from the standpoint of their adaptability to aerial fire-control experimentation.

Continental Area.—Two and one-quarter million acres of roadless area; high, rugged, broken to some extent by barren, rocky ridge tops and open alpine meadows. Fuels in the timbered basins, mostly low to moderate hazard, with scattered pockets in the higher categories. Average fire occurrence, about 40 per season, 97 percent lightning-caused. Activity in the area confined to hunting, fishing, and other forms of recreation.

Coeur d'Alene Forest.—Slightly more than one million acres under protection, with an intensive road system. Area rough and broken, but continuously timbered with no breaks of consequence. Large continuous areas of medium to high fuels, with something over 100,000 acres of extreme artificial hazard in the nature of logging slash and smelter-fume kill. Average fire occurrence, about double that of the Continental Area or, on a per unit-of-area basis, four and one-half times as great, 30 percent being man-caused. Lumbering and mining activities extremely heavy, one or both being present over a large portion of the forest.

The Coeur d'Alene experiment differed from that of the Continental Area in that it was confined to the detection feature alone. Because of easy accessibility, suppression was handled entirely by small crews and station firemen, smoke jumping being considered impractical.

The experiment was conceived, developed, and carried out by the supervisor and his staff, with technical advice and assistance from the regional office. It is planned to continue during 1948.

PLANNING

Full advantage was taken of the knowledge gained in 1945 and 1946 in developing the combined ground and air detection scheme on the Continental Area. The first step was to make a 10-year study of fire occurrence on the Coeur d'Alene Forest, giving separate consideration to lightning and man-caused risk. A special hazard and risk-

[1] Hand, R. L., and Harris, H. K. preliminary report on aerial detection study. Fire Control Notes 8 (1): 28–32, illus.

zone map was prepared and the process of re-sorting the lookout system was carried out in the usual way by reference to seen area maps. This sorting resulted in the retention of 8 fixed and 3 moving detectors out of a total of 33 that had been in use previously, and the direct coverage was thereby reduced from 69 percent to about 43 percent. However, by careful selection, it was possible to attain approximately 90 percent coverage in the high-hazard fuels and other important areas with the 11 positions in place.

It was decided that two light airplanes would be required to build up the coverage to an acceptable level under the worst probable conditions and that three observers would be necessary to provide for the proper amount of relief during periods of excessive flying. A contract was prepared which resulted in securing a Piper Super Cruiser and a Stinson Voyager, both equipped with radio on the proper frequency and the Voyager also equipped for night flying.

Techniques developed in the Continental Area were employed in perfecting general patrol routes, but it was found that much depended upon the ability of the observer and his ingenuity in seeking out and testing new methods. With the more intensive coverage confined to a smaller, compact area of high occurrence and with high-grade observers employed and used for that purpose alone, it was possible to make considerable progress. An indication of the increasing effectiveness of the air patrol is shown by the record of first discoveries.

From July 1 to August 2, the airplanes discovered only 2 out of 50 fires, or 4 percent. During the remainder of the season, which ended early in September, the air patrol is credited with 20 out of 89 fires, or 22 percent. This improvement is believed to be due not so much to increased flying, but rather to more effective flying.

The season of 1947 on the Coeur d'Alene was not bad from the standpoint of burning conditions, but well above average in intensity of the fire load. Several peak loads of 25 fires each were handled, apparently with no greater difficulty than under the old system, and a post-season analysis of discovery time for the past 10 years, shows an improvement in 1947, so far as average discovery time is concerned. Actually, when considering all groups from 15-minute discoveries to the long-time "hang-overs," there was no significant change, the 1947 record comparing favorably with the average of the 3 highest occurrence years in the past 10.

COSTS

In regular P&M funds there was a direct saving of $4,000 over what would have been spent under the old set-up. It is not quite so easy to make direct comparisons in the FFF cost item, but the total amount expended on the forest was $17,000 less than in 1946. The Coeur d'Alene was the only 1 among the 11 "fire forests" in Region 1 that did not find it necessary to spend FFF to place emergency lookouts despite a similar fire danger rating. Many Coeur d'Alene fires were scouted from the air, and false alarms were investigated, using P&M funds. None of the flying time was charged to FFF, although a good many hours were outside a lookout's regular tour of duty, and no week-end lookouts were financed from FFF. All of this served to hold down FFF charges without using any of the P&M savings.

CONCLUSIONS

We have yet a lot to learn about air detection and it would be presumptuous to make definite conclusions or predictions on the evidence of a single season's operation. However, the following statements, quoted from a preliminary report submitted by Assistant Supervisor Frank Blackmer of the Coeur d'Alene, reflect the concensus of those who watched closely or participated in the experiment:

1. We expected that it would not be easy to get cross shots on fires and that this would handicap smokechasing. Actually, this did not prove as serious as might be expected. This year with fewer lookouts we were able to train them better and they all became quite proficient in locating fires with only one shot. In addition, the plane was often used to help locate hard-to-find fires.
2. The planes cannot be in the air during a lightning storm. This is a handicap, but records show that in the past, only 26 percent of the lightning fires are discovered during the first 15 minutes. Because we had only "key" points manned in 1947, we still got 20 percent and the plane equipped for night flying was able to get into the air at night just as soon as the storm died down. The use of planes at night needs more study. We can find the fires but with present equipment, it is difficult to get an absolutely accurate "fix."
3. We knew finding hang-over fires from a plane would be difficult since they often puff up only intermittently. The record indicates that we did almost exactly as well finding hang-over fires as the 10-year lookout average and we think we can do better. One idea we want to try is a hang-over flight at dawn to try to pick up the smoke just as it starts to rise.
4. Results indicate that a qualified air observer can with practice give a very good fire location. He can also give additional information not available to a lookout that is of help to the smokechaser.
5. In general, communication was not completely satisfactory. All too often, there was a great deal of static and the observer had to spend time and energy "fighting" his radio which handicapped his detection effort. Very high frequency radio would probably be the answer. (Region 1 plans an FM net on the Coeur d'Alene as soon as possible.)

In conclusion, here are a few facts that seem to stand out clearly. First, in air detection we are dealing with something for which the future holds great promise. Ground detection techniques are well established with relatively little prospect of startling new developments. In air detection we have most of the "bugs" yet to work out. Second, the flexibility of air detection is particularly adaptable to the unstable and fluctuating pattern of the fire seasons, allowing opportunity for considerable savings if properly applied. Third, no direct comparison between air and ground detection is necessary or even possible at the present time; it is a matter of proper balance between the two services.

FIREFOG UNIT

A. B. Everts
Fire Staffman, Snoqualmie National Forest, U. S. Forest Service

Men who have had experience with grass fires know that it takes a relatively small amount of moisture to control or extinguish them. In the extensive cheatgrass areas of the West, fires frequently slow up or go out entirely in the late afternoon or early evening due to the moisture picked up from the air. However, fires in cheatgrass type are exceedingly fast spreading and it is not uncommon for them to burn 20,000 acres or more in an afternoon. And while the fuel is light, the momentum built up by such fires often sweeps them across plowed lines and even wide highways.

In South Dakota last fall, prairie fires swept over 380,000 acres of farm lands in 2 days, with losses in excess of 2 million dollars. Hastily plowed lines failed to stop the spread. It was necessary for fire crews to drop back to roads and backfire, and even this technique failed to work in many cases. Backfiring, under such conditions, is a science. It must be quickly and completely done; otherwise the backfire is apt to outflank the firing crew.

Since 1946 the Snoqualmie National Forest has been experimenting with a combination fire and fog unit attached to a tank truck, as a means of backfiring rapidly in grass types and holding the backfire with a fogged line. To date, four models have been constructed and three of them have been tested. The first two units were makeshift, but performed sufficiently well to justify further experimentation. In 1947, All-Service funds were allocated for this development, and the third model was constructed. At that time, we were still thinking of confining the idea to the control of grass fires.

This unit consisted of an angle iron A-frame, resting on a 10-inch rubber-tired caster and attached to the rear of a tank truck. A reversible fog-burner plate was carried in a slot in the center of the A-frame. On one side of this plate, liquid gas burners set the backfire, while on the other side, a single 1-inch low-pressure, low-velocity fog nozzle controlled the line.

In field tests conducted in September, we were able to fire and hold a line in cheatgrass at 8 miles per hour (fig. 1). Burning conditions were very unfavorable, with relative humidity 41 percent and wind 13 miles per hour. Previous short tests had shown that the better the burning conditions, the better the unit worked.

Further tests were made a week later on the Fremont National Forest in a sagebrush area which had been so heavily grazed that little grass remained. The line held on the windward side and to some extent on the flanks, but failed to hold on the lea side. It was reported that, because of the low position of the fog, the fire crossed the line through the tops of the sagebrush in some instances. Grazing men felt, however, that a unit of this kind might be used to handle fires in the lower sagebrush types.

FIGURE 1.—Control line in cheatgrass type, constructed in the September 1947 test.

In these tests, it was obvious that many improvements in the design and construction of the unit could be made. It was, therefore, decided to assign the old unit to an east-side forest and to construct a new one for further experiments in 1948.

The new unit (fig. 2) incorporates the basic ideas of the earlier models, and, in addition, the idea of using Diesel oil in combination with liquid gas. The various parts are as follows.

The carrier arm consists of four 1-inch square pieces of steel tubing, 6 feet long and welded together. It is attached to the rear of a tank truck, at the outside edge, by means of a bracket. This bracket allows the arm to move up and down but not sideways. The arm is held in a horizontal position by a chain attached to the truck. The four steel tubes also serve another purpose: To carry, respectively, the water, gas, oil, and ignition lines.

The burner assembly consists of a plate, locked between the tubes, on which are mounted three liquid gas burners. Each burner can be independently locked, by means of a hand screw, at any desirable angle. Each burner has its own shut-off valve and its own spark plug for ignition. The middle burner is also provided with an oil

jet, which has a number of adjustments from a long throw of 10 feet or more to a short, bushy, but terrifically hot flame. By properly adjusting the gas and oil, it is possible to leave a trail of burning oil on the fuel close to or several feet out from the fogged line.

The water bar is a 4-foot length of square tubing, the short end of which is counterbalanced with lead. This is to equalize thrust against the ball-bearing swivel coupling. The bar can be mounted either above or below the carrier arm, and also adjusted for angle. Three adjustable joints are spaced on the bar to receive the ¼-inch spray or fog tips of whatever design and water capacity is desired.

The control panel is an aluminum box containing the gas-control valve, oil-control valve, water shut-off, water strainer, and batteries, coils, and mechanism for lighting the burners. All control is in this panel. All fittings are of the quick-coupling type.

Gas and oil tanks are standard propane or "burner gas" tanks. One gas line runs through the control panel to the carrier arm. Another gas line runs to the oil tank. This line pressurizes the oil at about 100 pounds and forces it through the control panel to its tube on the carrier arm.

Fog and spray noozles of different types are on hand. These vary from free-floating fog to the driving type of jet noozles. Gallons-per-minute water consumption varies from 1.7 for the T-jet to 8 for the square spray.

Since this is still a test unit, all possible adjustments were provided so that tests could be made in different fuel types. Provisions have

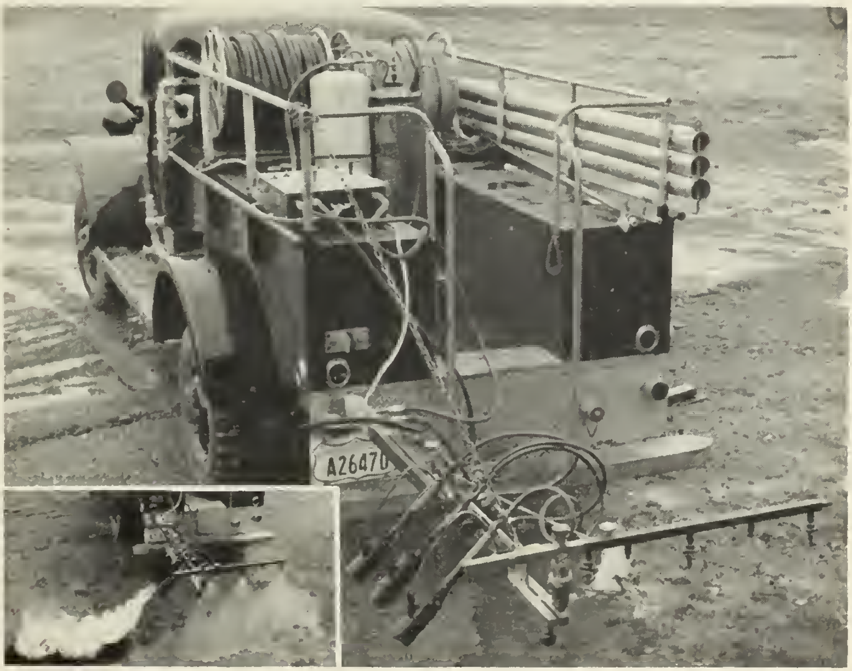


FIGURE 2.—The latest firefog unit mounted on a 1-ton 4 by 4 tank truck. Insert: Firefog unit with oil burner partly turned on and fog tips delivering 2.9 gallons per minute each at 150 pounds per square inch.

been made for using up to six spray tips if necessary. Width of fogged or sprayed line can be varied from 1 to 8 feet, water use from 2 to 22 gallons per minute.

It was found in the tests last fall that free-floating fog is dissipated considerably by the wind. The driving type of jets now on hand will overcome this difficulty. The addition of oil to the middle burner will easily handle the hard-to-ignite fuels. It was also found that the crushing effect of a dual-tired truck on the fuel was of some aid in constructing a line from which to backfire. For this reason, the carrier arm is mounted at the edge of the truck. An extra bracket is provided so that the arm can be moved to the other side of the truck, the burner assembly reversed, and firing done on that side. However, this may not always be necessary, as the burners can be adjusted so that they will shoot under the carrier arm and the water bar can be swung around to the opposite side in a minute.

It is obvious that the firefog unit will have the greatest operability if used on 4 by 4 tank trucks—possibly it can be used in areas with slopes up to 30 percent.

While intended primarily for fire suppression, the unit can also be used to burn out strips along roads, highways, and railroad rights-of-way as a fire-prevention measure.

Extensive field tests of the new unit are planned for next fall. This should furnish information as to just what an all-round unit should be, so that the design can be simplified as much as possible and a detailed specification can be written.

Report on a Wetting Agent: Drench.—We used "Drench" on the Dark River Fire (Mesaba No. 8) on October 19, 1947. The fire truck carried one ½-pint bottle of Drench for each back-pack pump. The chemical was poured into the 5 gallons of water in each pump can before packing the can to the fire.

Used with the spray nozzle, the first stroke pumped out a milky, frothy spray. The burning fuel was part swamp grass and part highland grass, dead—a hot fire. Each shot with the solution, however, immediately and completely put out a sizable spot of fire. It was fast and effective, and we are well pleased with the results of this trial on an actual fire.

We now carry ½-pint bottles with our pick-up units. The pumper pick-up has an additional ½-gallon jug of the solution ready to dump into the tank. We will report further on this commercial wetting agent as we have occasion to use it.—Louis Tauch, *District Ranger, Superior National Forest, Minn.*

MODIFYING THE ARMY INSECT SPRAYER (MODEL 3264) FOR USE AS SLIP-ON PUMPER TANKER ON ½-TON PICKUPS

Stanley R. Stevenson

Fire Control Staff Officer, Cleveland National Forest, California

To aid in meeting an increasing demand by field personnel for one- and two-man slip-on pumper units and temporarily replace pumpers worn out during the war years, the California Region of the United States Forest Service secured 83 Army insect sprayers (model 3264). They were purchased from the War Assets Administration in the spring of 1947 and used unaltered as slip-on pumpers on pickup trucks with reasonable success during the 1947 fire season.

The sprayer units consisted of a small, 2-cylinder plunger-type pump, powered by a V-belt drive from a 2-horsepower, 4-cycle, 1-cylinder, air-cooled engine. The pump and engine were mounted on a 50-gallon steel tank which, in turn, was mounted on wooden skids (fig. 1).

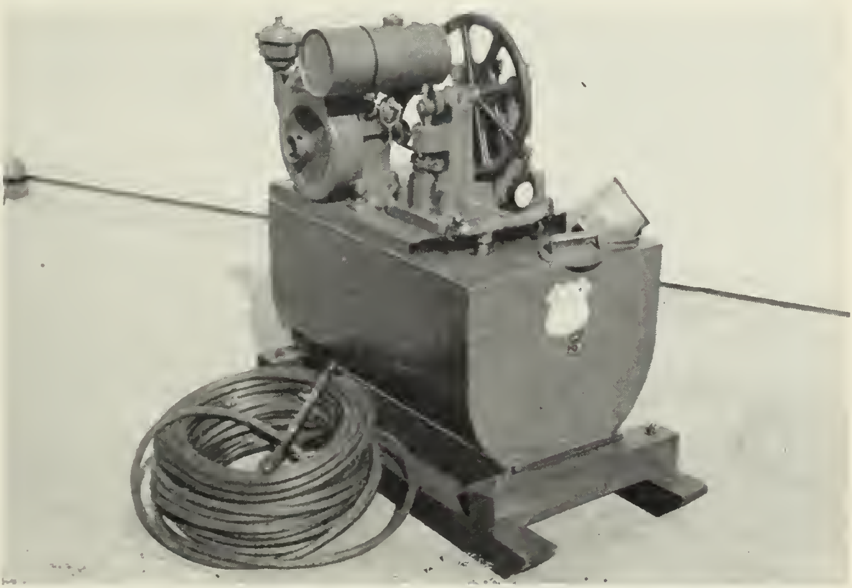


Figure 1.—Army insect sprayer (model 3264) before modification.

The units are capable of delivering 3 gallons per minute and operating up to 300 pounds per square inch discharge pressure. Accessories included 150 feet of ⅜-inch oil-proof rubber hose, spray nozzle, instruction books, and necessary spare parts.

As a result of field use during the 1947 fire season several improvements were suggested. A pilot model was constructed and standard

alteration plans prepared by the United States Forest Service Fire Control Equipment Development Center at Arcadia, Calif. These plans incorporated field suggestions and utilized the original parts and materials as much as possible (fig. 2).

The following alterations and additions were made in the order listed:

1. Replaced skids with 4- by 4-inch timbers long enough to allow in-line mounting of tanks and engine-pump units.

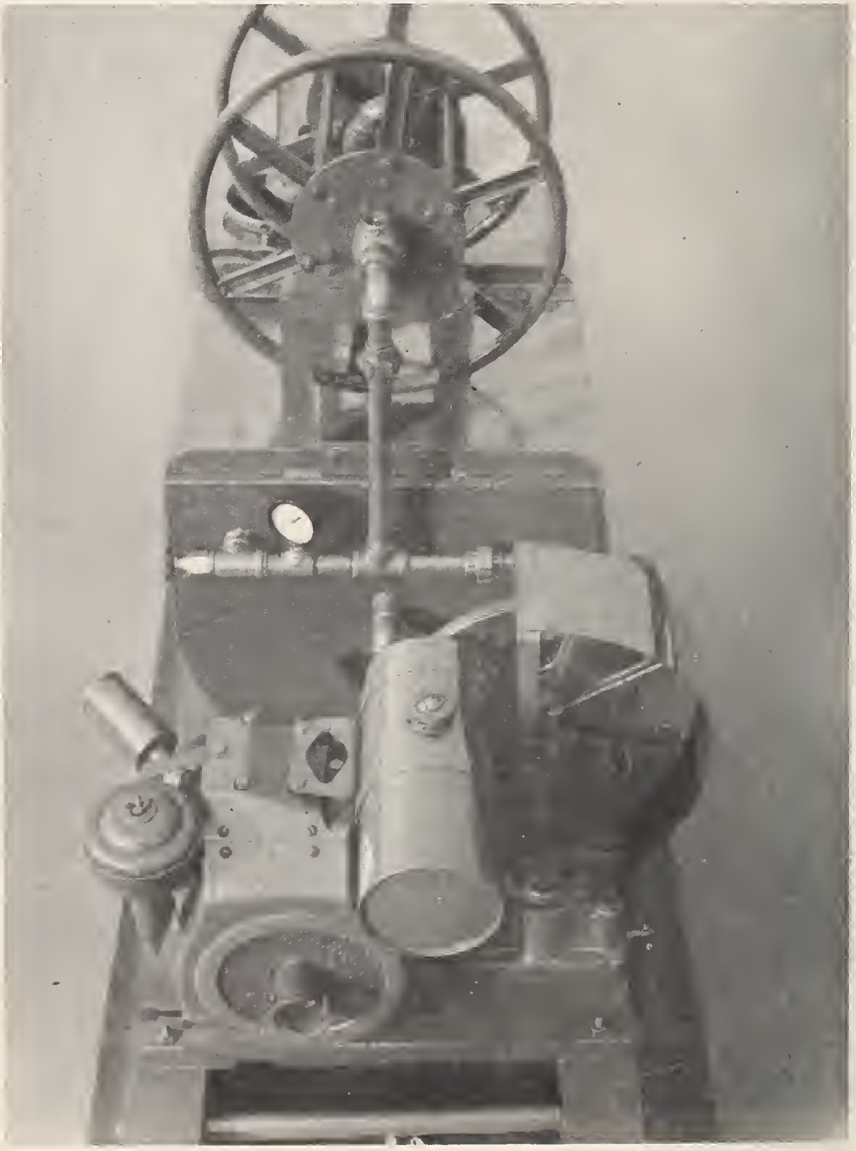


FIGURE 2.—Converted Army sprayer with engine and pump mounted in line and the live hose reel added.

2. Removed and discarded the agitator, shaft and suction strainer from the inside of the tank.
3. Installed new drain in the end of the tank.
4. Welded up all original holes in the tank, except the filler cap.
5. Welded new suction and return outlets into the end of the tank.
6. Added a clamp for fastening filler cap securely.
7. Attached a live reel capable of holding 200 feet of ⅜-inch high-pressure hose to the top of the tank.
8. Repiped the pump to the new tank outlets using as many of original fittings as possible.
9. Installed a safety guard over pump pulley.
10. Painted the entire unit except for the engine cooling fins.

The adaptations greatly improved the units by lowering the center of gravity, by making live reel operation possible, and by sealing several openings in the tank to prevent loss of water on rough roads.

The output of the pump was not affected by the alterations. Since the pumps were designed primarily for pumping Diesel oil and spray chemicals, they may not last more than 2 or 3 years in water-pumping service. However, since the cost of the entire unit was less than the normal price of the engine alone, suitable water pumps will be economically justified when and if it becomes necessary to replace the original pumps. Care in draining original pump after use and properly lubricating valves, piston, etc., will greatly aid in prolonging the life of the unit.

The adapted sprayer mounted on a pickup truck (fig. 3) is well suited for patrolmen or two-man crews covering light, flammable cover areas. One man can successfully handle the small ⅜-inch hose unaided and is assured of at least 15 minutes of continuous water application

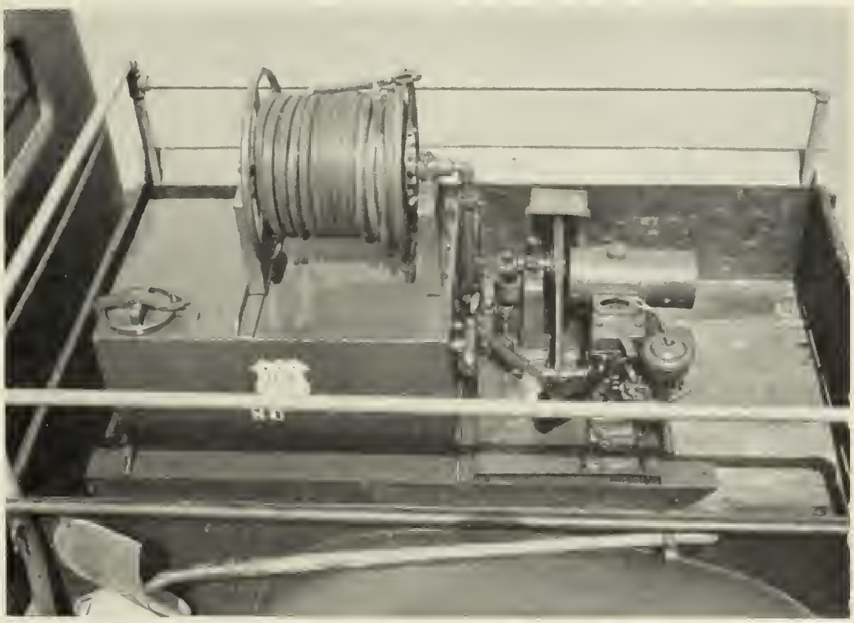


FIGURE 3.—Converted Army sprayer in a ½-ton pickup truck.

at maximum pressure and volume. The pumpers have been effective in suppressing fires in grass and light brush where fog and light sprays can be used successfully. The adjustable nozzle offers a limited selection of straight stream, spray, or fog application.

The Army sprayers were purchased new for $75 each. For each unit the conversion work, which is being done by local Forest Service equipment service branch shops, will cost approximately $55 for labor and $35 for parts and materials. The parts include $28 for the live reel. The total cost of each converted unit will be approximately $165.

Fire control agencies interested in the detailed drawings of the alterations can secure copies by writing to Arcadia Fire Control Equipment Development Center, 701 North Santa Anita Avenue, Arcadia, Calif.

Headlamp Modifications Required for Use of Metal Clad Batteries.—The use of metal clad flashlight batteries such as Ray-O-Vac has produced a material saving in our funds, because they have a much longer shelf life than the regular type battery.

Ray-O-Vac batteries will work satisfactorily in the new type 4-cell headlamps (F. S. Specification 178 Revised February 1947). Until the old 3-cell type flashlights are replaced by the new 4-cell type, a simple modification in them is necessary. The cup which contains the spare light globe in the base of the 3-cell battery case is too large in diameter to make a proper ground with the bottom of the Ray-O-Vac battery. This can be remedied in two ways. We recommend the second as the more satisfactory method.

1. A metal strip bent slightly convex is inserted at the base of the battery. This metal clip can be made of band iron 1⅜ inches long by ½ inch wide. This will give the necessary contact, but the metal strip is easily lost in changing batteries.

2. Remove metal cup containing spare light globe from base spring by cutting rivet with side-cutting pliers; remove spring from screw cap; place cup containing spare globe (globe side up) in screw cap; stretch spring about one-half inch and replace in screw cap over cup containing spare globe. Cup containing globe will rattle, unless soldered or riveted in place, but will not fall out unless spring is badly twisted out of shape. Soldering of cup in place is not recommended. Spring will now give satisfactory contact with all batteries, including Ray-O-Vac.—Ira C. Funk, *Mechanical Engineer, Equipment Development Center, Region 5, U. S. Forest Service.*

MISUSE OF THE FIRE DANGER METER

Arnold A. Buettner

Forest Ranger, Wisconsin Conservation Department, Antigo, Wis.

The Lake States Burning Index Meter, or "fire danger meter" as it is commonly called, is extensively used throughout the forest protection districts and probably is almost as much misused.

The meter, or burning index as it should rightfully be called, was prepared as a result of many experiments with every conceivable fuel type, temperature, air and fuel moisture condition, long and short periods of dryness, and large and small amounts of precipitation. As a result, it gives an accurate burning index on the factors mentioned.

Since the research work I have done on the precipitation and time factors produced nothing substantial to discredit the burning meter index, an explanation of the emphasis actually placed on these factors in its construction may clear up the skepticism of some of us toward it.

Numerous experiments showed that fuel moisture and air moisture, or absolute humidity, reach an equilibrium about 3 days after a rain. After that, the moisture in the air is the controlling factor for critical fuels. This fact was carefully incorporated in the burning index.

Some of us might not agree with this since the burning index places an increasing value on each day from the time of the last precipitation. This value is small with low hazard but increases daily with a larger rate with higher hazard. The reason for this is that "safe" is 0 to 1 percent while "extreme" is 50 to 100 percent. Therefore, an increase of 5 percent with "extreme" indicated conditions is, in reality, much smaller than 1 percent in "safe" or "very low" indicated conditions.

Most of us can remember the time when the duff hygrometer was considered to be the meter to measure hazard. It was found, however, that a dozen different readings could be obtained in the same number of tests made in close proximity. It, therefore, lost its popularity. Although the burning index or danger meter takes into account a number of factors, it can also be as unsatisfactory. This is particularly true during the shower months of July and August. A shower of considerable amount of precipitation and local in extent may occur at district headquarters and change the burning index to safe, while most of the district actually has a high burning index. In other words, it would be similar to sticking a duff hygrometer in a mud puddle; the reading would be as accurate. Of course, judgment enters into the picture and fire control measures are then based on judgment and the burning index is disregarded.

All these years we have been taking weather observations and computing the burning index for Weather Bureau purposes only, generally speaking. The burning index was correct for the headquarters and immediate vicinity but I doubt whether it gave the average burning

index or fire danger for the district more than 30 percent of the time. It would be correct only during the spring (June) and fall (September) seasons of general rains of considerable amounts at which time an accurate reading would not be too important. It can, therefore, be concluded that the misuse of the burning index is the reason for unsatisfactory results rather than the meter itself.

Since air masses are homogeneous in character over a large area, it can be assumed that the moisture content of the air (absolute humidity) would be the same. It would, therefore, be possible to compute the burning index for a whole district, or the whole State in fact, from a single observation station. The observation would apply to the whole State as far as humidity, wind velocity, and, in most cases, stage of vegetation are concerned. Now if we took the average of the "amount of last rain" from the various rain gages throughout the district and the "days since rain" on the same basis, the burning index would be accurate over more area than the area covered by the district headquarters.

A good example of how erroneous the district headquarters burning index can be occurred in district four in August 1947. The last rain that was general fell on August 2, 1947, and ranged from 0.01 to 0.19 inch. On August 6, 1947, 0.07 inch occurred at Antigo, the district headquarters, and covered about 3 square miles in extent. On August 13, another 0.10 inch occurred at Antigo and lesser amounts at a few other points. A thorough check on this rain by rangers examining old fires in various parts of the district and by towermen reporting at towers, plus a careful check of cloud and shower movements, indicated that about 20 square miles of the 1,632 square miles of the district were covered. The district headquarters burning index, therefore, applied to less than 2 percent of the area. If the average were taken of the lowest precipitation that occurred at three of the five substations in the district, the burning index would have applied to 98 percent of the district and would also have indicated the worst possible burning conditions. The tower manning schedule and number of stand-bys per station would have been correct and personal judgment would not have entered into the picture.

This example illustrates the erroneous use of the headquarters burning index from August 2 until August 19, 1947, when the entire district received over a half inch of precipitation and the headquarters burning index again applied to the entire area.

We have been discussing burning index. However, before outlining my recommendations for computing fire danger, I would like to consider risk and fuel in relation to fire danger.

Risk, i. e., the causes of fires, in Wisconsin is 98 percent human element and 2 percent nature. We can break the human element down into the main responsibility classes: farmers or settlers, fishermen, berry pickers, and hunters. Each should have a positive value to be considered with the burning index. For example, in the spring shortly after the snow is gone, there are hundreds of farmers burning debris, a potential source of hundreds of forest fires. For the same burning index the danger is greater then than it would be with very few farmers burning. The factor could be determined by the number of burning permits issued, for example, 100 to 199, factor 1; 200 to 299, factor 2; etc. The dispatcher at the district office could determine

the factor by the number of active permits on file. Fishermen could be treated similarly with the highest value or factor assigned to the opening day of trout season, the factor decreasing until the season's end. Berry pickers could be handled in the same manner as the various berries ripen. Similar factors could be given hunters during the hunting seasons.

However, it may be very difficult to place any values on fuel since they vary by districts, by type, arrangement, and amount.

The United States Forest Service, in its booklet Representative Fuel Types, has given us 38 fuel types arranged in 15 groups on the basis of rate of spread and resistance to control for spring and summer conditions, based on class 5 day. J. A. Mitchell, of the Lake States Forest Experiment Station, has recently completed a statement and tables dealing with rate of spread in fuel types with varying wind velocity and burning index. Consideration is also being given to reclassifying and reducing the number of fuel types. When this is completed, it will materially aid placing a danger factor on fuel.

At present throughout forest protection districts, an attempt is being made to prepare hazard maps from information gathered during inspections in the enforcement of the slash law. If a standard classification of fuel types were adopted, and used throughout all districts, a fuel factor could be determined for each district on the basis of percentages of the district under each fuel type and values placed on each type. The fuel factor could be also determined for subdistricts or even areas within visibility range of a tower.

Briefly, fire danger then would be based on all three factors necessary for starting a fire, namely, burning index; risk or human element, the spark or kindling agency; and fuels.

This method would strengthen the fire danger determining system by incorporating more factors. It would tend to eliminate chance since it weighs all factors, automatically increasing the hazard rating when a high fire starting potential exists and likewise reducing the hazard rating when there is very little burning being done and few people are in the woods. It will also increase the hazard rating in districts or areas with critical fuel types, and reduce it in others, definitely defining boundaries of areas on questionable days when part of the towers are to be manned and where ground crews can work.

Let us examine the method. For example we assume the burning index is 2 percent, which is a questionable point whether to man towers or not. There are over 300 active burning permits out, so let us say the risk factor is 3 percent. The district fuel factor we will say is 2 percent, making a total of 7 percent, indicating that the towers should be manned, and also indicating a stand-by of 2 men per station since fuel types are involved.

In another example the burning index is, let us say, 4 percent. There are very few farmers burning and no hunters, fishermen, or berry pickers, so the risk factor is zero. The time is late summer when fuel types are still green or dead fuels are mixed with green undergrowth. The fuel factor would be low, let us say 1 percent, making a total of 5 percent.

The second example has a higher burning index, but the other factors indicate a lower danger. Probably by using the three factors for determining danger, the maximum safe period could be placed at 6

percent. It would still mean that towers would be manned in the spring when the burning index factor is 2 or 3 percent but the other factors are high. Our present suppression system would be affected in that we would further strengthen our force when necessary and reduce to a greater extent when all factors indicate such a step to be safe.

Two recommendations are submitted for determining the burning index and fire danger.

1. Burning index for the district should be determined by using the lowest average district precipitation rather than headquarters reading. The precipitation totals from the substations and from any additional permanent gages where an accurate reading can be obtained daily should be classified in groups, 0.01 to 0.19, 0.20 to 0.49, 0.50 inch and up. Whatever group represents the largest part of the district should be used. For instance, four gages read 0.14, 0.24, 0.28, and 0.59 inch. Two readings fall in the 0.20- to 0.49-inch group, and, therefore, this group would be the one used in determining district burning index. The substation falling in the group lower than the one used would have to be considered separately. The present method should be used only for Weather Bureau reports, while the district burning index can be given on dispatcher's record and all forest protection reports. This will not increase the dispatcher's work load since the precipitation is called in daily from all substations. The weather pad is provided with extra columns in which district burning index can be recorded.

2. Fire danger should be calculated from the three factors, burning index, risk, and fuel, instead of from burning index alone. This should be done as soon as values can be placed on risk and fuel.

The risk factor can be determined by assigning positive values for farmers, based on the number of active burning permits; for hunters and fishermen, by seasons; for berry pickers, based on abundance of berries and when they ripen; and possibly for section crews during periods when they are doing right-of-way burning. The risk factor would then be the total of values for the responsibility classes applicable at the time plus a value for the class of day. The reason the class of day is taken into consideration is that the fire starting potential increases with an increase in the burning index.

The fuel factor may require considerable work. The fuel type classification needs to be standardized and hazard or fuel type maps completed for the district. When values are given fuel types, the fuel factor then would be fuel type value (based on rapidity of spread and resistance to control, at present for class 5 day) plus wind value (based on Beaufort or similar scale) plus class of day. If present fuel types were used, the class of day value would be a minus quantity for classes 1 through 4, a zero quantity for class 5, and a plus quantity for classes 6 and 7.

The recommendations and methods given are merely a different approach to rating fire danger. Some of the points outlined may have some value while others may be replaced by something much better. Nevertheless, if the material herein presented is of enough interest to arouse thought or discussion among the readers, something substantial in improved methods will surely follow, and the work already done by many will be incorporated in the results.

FOREST SMOKECHASER—A REGION 4 FIRE FILM

J. W. Mattsson

Forester, Fire Control, Region 4, U. S. Forest Service

Forest Smokechaser, Region 4's new 25-minute color fire film was released in November. This training film sets something of a record in fast and economical production. Field work began in September and took about 2½ weeks; cutting, final narration, and work print work were completed in October; processing at the Calvin Co. was done the first week of November. The over-all cost for producing this film, including processing, a master print, and contributed time is around $2,200. Prints are available to any interested region or other agency through the Chief's office and the Calvin Co., Kansas City, Mo.

This training film shows a forest smokechaser in action. The story stresses the work necessary to control a small hot fire and follows a smokechaser-lookout from the time of sighting a timber smoke until he finally suppresses the fire. The film is full of sound fundamental training practices in suppression tactics, including scouting, hotspotting, line building, and mop-up.

The actor, John W. Parker, Forester in the Division of Fire Control, Region 4, has been chasing smokes for 15 years. Parker, together with Director Horace E. Hedges, regional safety and training officer, and the writer who did the camera work, made up the production team. All three have had a good background of actual experience in fire suppression and with the knowledge gained from producing two other films in the preceding 2 years were in a pretty good position to turn out a worth while fire training film. The locale of the new film is the ponderosa pine belt in southern Idaho, country with fuel types typical of much of the western regions.

For those that have a desire to develop some training films but have hesitated because of high production costs and other problems, we want to take this opportunity in Fire Control Notes to point out some of the production problems and difficulties we encountered. We are highly optimistic in Region 4 that good films can be made without Hollywood budgets or professional actors, cameramen, or producers. It does, however, take a lot of enthusiasm and backing.

The following are points picked up in producing three films in Region 4 the last 3 years. No attempt has been made to go into technical production problems.

Administrative enthusiasm.—The basic requirement is to have the interest and enthusiasm of the Boss backed up by willingness to earmark dollars, time, and effort, with emphasis on the last two. Sure, delegation of authority is a necessity, but just as necessary is a central

spark plug who will drive right down the course until the final cutting is done—someone who will follow through from the original idea and keep a close watch on developments right up to the final processing.

Adequate advance preparation.—This includes finding out what is wanted—reducing discussion generalities to specific practical production plans; getting departmental and interdivisional deadlocks out of the way before field work begins, and slugging a clear path for production. A fundamental prerequisite is the formulation of a story or a theme, some human interest central theme that preaches what you are trying to get across. This forms the basis for the rough shooting and narrative script. This working script should tell the story in logical sequence, and if it does you are bound to tell the same story in pictures.

Equipment, films, and facilities.—The minimum equipment required for an outdoor film is as follows:

- Professional 16-mm. camera.
- Dependable light meter.
- Sturdy tripod and T.
- One-inch lens.
- Two-inch lens.
- Wide angle lens.
- Small slate and chalk or number board.
- Reflectors (exterior), homemade tinfoil frames, costing about $2.

If some inside shooting is planned, you would have to add floodlights, cable, and spots to the list. We have found it pays to hold inside shooting to a minimum; it is costly and time consuming, especially if any animation or complicated graphs or charts are included.

Plan to buy enough film at one time so the emulsion number is the same. This will aid in getting uniformity in color. You will need about three times as much film as you contemplate for the length of the finished picture, that is, a 1,000-foot film would generally require that you expose between 2,500 and 3,000 feet of film. A standard practice of 16-mm. professional producers is to shoot each scene twice; the first exposure set from a normal meter reading and the other at ½ stop light, opening up and getting a lighter scene.

One thing we learned the hard way—be sure and shoot each scene plenty long—and get extra footage on each end even though you later cut a lot of it out. You never know when this extra footage will be needed for titles, flashes, to catch all action, or to fit in with desired narration.

Practice action.—The best hours for photography are from about 10 a. m. to 4 p. m., but avoid high noon. At this time the lack of shadows seems to give a flat effect and the exposure is unnatural, especially for close-ups of people. This does not mean your working hours are limited to between 10 a. m. and 4 p. m. Before and after these hours you can get in your best licks practicing and going over actions, getting ready to shoot, and working out the next day's shooting schedules.

Tell your story in the photography.—Make your pictures carry the story, don't depend on the narration to do it. When shooting single action scenes consider all supporting action for them. Get the scenes full of primary and secondary action, this rids them of choppy sequences and helps develop the story. Don't shoot every scene from the same angle. Use close-ups, medium shots and long shots, high angles, low angles, and so on. These are mechanical aids in telling

your story. The long shots orient the audience; medium shots center attention on a definite subject first seen in a long shot; close-ups focus specific attention and magnify the impression, thus enhancing the teaching value.

Opportunity shots.—Don't depend on opportunity shots in outlining the shooting script but take advantage of those that will continually show up while you are in the field. Many times you can slip them in for a really good dramatic effect. You are not hidebound by the original shooting script. It is only your working guide.

Choice of actors.—Professional actors are not the best for our type of films. Individuals familiar with the subject and whose physical actions are easy and sure can do a good job under a little good direction. For example, someone who has a lot of practical experience in the use of a Pulaski, saw, or ax, can demonstrate the cutting down of a snag much more realistically than could someone who, although more photogenic, does not have the know-how that comes only with a lot of doing.

Choice of equipment.—Use up-to-date equipment and the latest approved techniques. Don't compromise, for example, on an "old 35" if a new RD–6 is what you want.

Choice of site.—We found that the time taken to pick a suitable site really pays. In this new film, for example, the 2 days required to find a suitable site made it possible to get all the desired shots within a small area, thus cutting down on travel time and other preparation. If your film is to be a fire picture try to avoid the use of oil or other substances to "soup" up the fires. "Souped" fires never look right. Experienced fire men know how normal smokes look. This is another factor that can be avoided by careful selection of a site and timing production to get good burning conditions.

Weather Bureau forecasts.—Good photography requires plenty of sunlight, absence of haze, especially on long shots, and clear days. We depended a lot on our direct contact with the Boise Weather Bureau for forecasts while we were filming this new picture. Luckily we could talk with them by phone over a Forest Service line. Their forecasts materially aided in planning the field shooting and served as a reliable economy measure in hiring additional help.

Animation.—If you have to have animation, hold it to a minimum and plan it carefully to avoid costly reshooting. It's difficult and expensive.

Extra help.—You will usually need some laborers for the rough work. They can speed up production a lot by relieving the production team of setting fires, putting them out after shooting, moving equipment, preparing safe fire lines, and so on. The number, of course, depends on the type of film you are producing. Hold them to a minimum because here again is a cost item that can be controlled.

Technical assistance.—While preparing original working script and doing field work, the production team, especially if it is not conversant with the subject, will find technical advisors sometimes help a lot.

Work print.—By all means, get a black and white work print even though your original may be in color. You can do almost anything with it and won't have to worry about scratches, lost film, breakage, etc. *Guard that original.* All your subsequent prints depend upon

it. Careless and unnecessary handling of originals will plague you for the life of the film. Don't run it through the "flicker" or projector if you can avoid it. If necessary to project the original once, be sure the projector is extra clean and loosen up the film gate to ease the tension on the film.

Editing.—Here again we found out how to do it the hard way through trial and error. We estimate it took us about one-fifth the time on the last film for this part of the process as for the first one. This was due to a lot of practical little things that we developed in this work. We will not enlarge upon them here, but would be glad to pass on what we learned to any interested region or agency. The following equipment seems to be about the minimum necessary for editing:

Well ventilated darkened room.
Wall film rack.
Viewer or "flicker." (Greig or Film are good.)
Rewinds.
100-foot reels and some larger 300- or 400-foot ones.
A good splicer, cement and scraper.
Wiping cloth.
Extra leader.
Scissors.
Pen and ink, and grease pencil.
Double-thread projector.

The master script.—The master script is the final written form, revised for recording. Get all the help and advice you feel necessary from skilled writers and regional trainers. The Divisions of Information and Education and Personnel Management can give you a lot of sound advice in wording the narration from the training angle. *Write to the scene and action*—this is important and a timesaver. After getting the script in final form, get some administrator to spark plug it through, preferably the boss whose enthusiasm carried the film to this stage. You will save endless arguments and changes by having him say, "This is it."

We have just touched the highlights of some of the production problems encountered in producing the new film, Forest Smokechaser, and the two others preceding it. It is hoped that the above at least indicates that regions can make pictures, fairly successful ones, too.

Protection of Tool Handles From the Powder Post Beetle.—Over a period several years the following practice in the control of the powder post beetle, in the storage of new handles and of fire tools in caches:

Place the handles in a vat of sufficient length to accommodate them and cover with a mixture of five parts used motor oil and one part kerosene. Allow them to soak for 2 days. Then remove the handles and allow them to dry 1 day in the air before wiping and placing in storage.—FRED G. AMES, *District Ranger, DeSoto National Forest, Miss.*

PROGRESS OF RECENT EQUIPMENT DEVELOPMENT

Equipment Development Committee

U. S. Forest Service

During the United States Forest Service equipment meeting in February many items of equipment being developed by the various Regions were discussed. Short narrative descriptions of each project were prepared and appear in the minutes of the meeting recently distributed to a limited group. Since a number of these narrative descriptions are of general interest, we are including them here.

REGION 1

Bosworth Trencher.—In further development of this machine, the plan was changed to provide for the application of power to the wheels as well as to the digging tool. This is accomplished with planetary gears. The latest model weighs 180 pounds. It has two wheels in tandem, a rotary digging tool with strap iron hammers mounted between rubber blocks, and a 6-horsepower engine. The digging tool is reversible. The fluid drive principle is employed. Different types of digging or sweeping tools could be used. The unit has been designed for dropping from an airplane if desired. From tests made so far, the superiority over hand tools is estimated at 10 to 1. Completion of the second pilot model is delayed by the difficulty of obtaining certain gears. Completion is expected by July 1. The cost in quantity production is estimated at $325.

Iron Mule.—This was described as a powered wheelbarrow, designed to carry loads up to 200 pounds on grades up to 35 percent. It is estimated to weigh 100 pounds and will be suitable for dropping from an airplane. The development is closely related to the Bosworth Trencher and will follow that development.

Scooter.—Region 1 had experimented with a scooter on trails for some time prior to 1945. In that year scooter development was assigned to Region 6. The Cushman scooter appeared to have possibilities for Forest Service work and an Army model was acquired. Certain changes were made in this model to adapt it for trail transportation, and later two commercial models were purchased by Regions 1 and 6. While this scooter is well constructed, tests showed certain disadvantages for use on forest trails. It appeared possible to develop a machine that would weigh less, have a shorter turning radius, and be easier to control on heavy grades and rough surfaces.

In 1946 Region 1 began experimenting with fluid drive applied to a trail scooter. Plans were also worked out for light-weight construction. The latest model weighs 180 pounds. The wheels are 18

inches in diameter over-all, and have 6-inch tires. Ample power is supplied through fluid drive from a light 4-cycle, air-cooled engine. The scooter performs well on horse trails if large boulders are removed and the bad sections improved. It will climb a 45-percent slope with one man. A local manufacturer has become interested in producing a commercial scooter with fluid drive and is willing to incorporate the features needed for trail operation. The cost is estimated at $300. At present scooters are classed as passenger-carrying vehicles. Steps should be taken to get the classification changed.

Aluminum Tanker.—This unit is mounted on a Dodge 4 by 4 chassis. It has a 200-gallon tank, a live reel, and compartments for rubber-lined hose and tools. A two-speed power take-off pump is used. Since the chassis has a power winch the power take-off drives the pump through a gear box. The body, spare tire, and reel weigh 830 pounds. With a full tank and all planned equipment loaded, the total weight is 200 pounds less than the manufacturer's rated gross weight for the vehicle. The aluminum units already constructed cost $2,000 each, but it is estimated that additional units can be produced for from $800 to $1,000 each in lots of 10 or more.

Smoke-Jumper Fire Pack.—This is a one-man fire-fighting outfit similar to a smokechaser's pack, but specially adapted for dropping to smoke jumpers. The development has been completed and the report will be available soon.

Slotted Freight Parachute.—The purpose of this development is to reduce oscillation. Tests made so far indicate that slots in a freight parachute will reduce oscillation materially. Further tests will be made before a report is compiled.

The Baker parachute, which has a center shroud line, has been tested to a limited extent in Region 5. The data will be turned over to Region 1, which will go ahead with the testing and report results along with the information on the slotted parachute.

Disposable Sleeping Bag.—So far no satisfactory disposable sleeping bag has been found, but paper manufacturers are interested.

Duffle Carrier.—The primary purpose of this development is to provide a means of bringing out smoke-jumpers' equipment without pack horses. The first model, which is ready for trial, consists of a Stokes litter mounted on a bicycle wheel. Another model has been designed with a 14-inch wheel to lower the center of gravity. It will be constructed of aluminum tubing, weigh about 36 pounds, and carry up to 200 pounds. It will be collapsible so it can be dropped from an airplane.

REGION 5

Fog Nozzles.—Equipment Development Report No. 11, March 1948, Characteristics of Certain Fog Nozzles, includes a condensed revision of the project report prepared by the University of California, Los Angeles Campus. Ten commercial nozzles of fog and spray type, with various tips, having discharge rates from 3 to 40 gallons per minute, are covered.

Experience on fires on the Cleveland National Forest during the 1947 season indicates very strongly that use of fog type nozzles made water about twice as effective as spray from garden hose type nozzles. Three-and six-gallon per minute fog tips were used in most cases,

although 8-gallon per minute tips were available. Garden hose nozzles used in the same fire situations have discharge rates of about 10 gallons per minute.

All low-pressure varieties of fog nozzles tested require a nozzle pressure of about 150 pounds per square inch to produce an effective fog; i. e., mist-size droplets. All have a critical range of pressure, usually from 90 to 130 pounds per square inch, below which they act as a sprinkler, producing a medium or coarse spray. As pressure is increased through the critical range, a larger proportion of the droplets become mist size. A few observers have noticed that the addition of a wetting agent when operating a fog nozzle at the lower end of the critical range will produce, to a certain extent, the same effect as increasing the pressure. Theoretical considerations verify this.

None of the fog type nozzles now on the market fully fills our need but at least two manufacturers are coming out, this spring, with new models designed especially for forest fire work.

Wetting Agents.—The superiority of "wet water," i. e., water with added wetting agents, is believed to be grossly exaggerated. Tests run to date have given contradictory results, because sufficient controls were lacking. Effect of technique and manner of applications apparently are of much greater importance than whether the water carries a wetting agent or not.

The development of this problem indicates several things. First, that more can be gained in learning how to most effectively apply plain water and in training nozzle men. Second, that perhaps the nozzle man is the most important man on a pumper crew, instead of the pumper operator. At least, more attention should be given to training and supervision of the men in whose hands is determined the effectiveness of costly units of equipment and organization. Third, that a series of standard test fires representing principal fuel types must be developed in order to evaluate differences in effectiveness of various wetting agents when applied in the most efficient manner. Obviously, to do this we must first learn by controlled experiments how to apply each most effectively.

The University of California at Los Angeles is now starting on the fundamental work in the above. During July the California Experiment Station and the Arcadia Center plan to run some semicontrolled field tests. These will give us a few quick answers on obvious points. If wetting agents have no obvious superiority, such as greater than 2 to 1, we will have to wait for more accurate determinations with laboratory controlled fires.

While we are waiting for positive proof of wetting agents, it seems reasonable that all regions should use them conservatively on mop-up. The advantages in mop-up are more obvious. If we do this, however, premium prices should not be paid for highly advertised specialty products. Such products have little or no advantage over wetting agents sold for general commercial use. Nearly all wetting agents are toxic, like soap, and nearly all promote rust and corrosion to a high degree. Many agents cause considerable foaming if the solution is agitated in the presence of air.

This particular phase of the use of water and chemical study is now of highest priority and results of tests will be published currently.

Other Chemicals.—Mono-ammonium phosphate (technical grade) is also a useful additive to water. Truax's studies show that a 5- to 10-

percent, by weight, solution is the concentration desired. This can be added to "wet water" to give an obvious residual effect. That is, after the solution has dried the mono-ammonium phosphate will retard, and in many cases extinguish, the fire.

Helicopter Tests.—See Fire Control Notes, January 1948, page 1; and this issue, page 5.

Portable Pumper Tests.—During the past years there has been developed at the Arcadia Center the apparatus and procedure necessary to run development tests on portable and semiportable pumpers, and approval test as required by Forest Service Specifications covering portable pumpers. During the current fiscal year three pilot models of new pumpers were tested, resulting in the development of a new light weight 4-cycle engine-powered pumper more suitable for use with fog nozzles and cotton-jacketed hose. Two other pumpers are scheduled for tests this spring. One is the new Edwards model 120 and the other the Porto pump.

Utility Trailer, Tractor Drawn.—See page 31.

Specifications.—This is a Service-wide project in which the Arcadia Center is collecting information on light alloys and rubber products, and testing procedures in order to improve specifications. It also covers development and testing work necessary to permit the writing of certain specifications and the photographic, drafting, and duplicating work connected with the preparation of all Service specifications.

Tractor Tanker.—Original tractor-tanker experiments were made with tanks and pumps mounted on crawler tractors. These all proved unsatisfactory, since the additional equipment and water reduced the performance of the tractor and interfered with other operations for which the tractor was used. The Army cargo carrier (M–29), better known as the Weasel, was selected in 1946 as the crawler vehicle most nearly meeting tractor-tanker requirements. Testing and use of the Weasel on fires shows that its performance looks very promising. Twelve modified units will be in fire control service in Region 5 this year. From experience with these units it is expected that plans and specifications can be prepared in cooperation with the Portland Laboratory that will give us a currently produced track-laying vehicle for general fire line hauling missions beyond the reach of all wheel drive vehicles. Experience on fires has already shown that the Weasel is so useful for laying hose lines and general hauling that any pumper-tanker equipment should be slip-on. E. D. Report No. 10, February 1948, Tracklaying Fire Line Transport, covers progress to date on this project.

Ram-Jet.—This is a project started in Washington by T. V. Pearson. It involves the use of the products of combustion from a jet engine (or automobile engine) to extinguish fires. The Aero Jet Corp. at Azuza, Calif., is working on it, and the Army Engineers Research and Development Laboratory is interested. In principle it is best suited for enclosed structures.

Tilt-Bed Trailer.—The original project included construction of two different size tilt-bed trailers. Survey of trailers commercially available showed that this was not necessary. Funds were therefore turned back and a small amount reallotted for further survey and preparation of drawings and specifications. Progress is now just under way.

Aerial Fire Suppression.—This project covers the use of spray or dusting type conventional aircraft in extinguishing or retarding the spread of fires. The present desire is to use helicopters instead of fixed-wing aircraft for the same purpose. No work done as yet.

REGION 6

Walking-Type Power Trencher.—This project was assigned in fiscal year 1946 and carried over to later years. The purpose is to provide a light trenching machine which can be handled by one man, with gasoline power applied to both the digging tool and tractor wheels, instead of to the digging tool only, as on the original Bosworth Trencher. All known makes of small garden tractors were investigated and it appeared that none of them was adaptable for the purpose. A trial unit was then assembled and experiments made with different kinds of digging tools. This unit had a 4-horsepower engine, which proved to be too light. However, from experience with the unit, the engineers were able to work out the design and select what seemed to be the best type of digging tools for conditions with which they are familiar, preparatory to assembly of another test model.

The design of the second unit has been completed and its construction is under way. It is expected that field tests can be started as soon as weather and ground conditions permit in the spring. This unit will weigh between 250 and 350 pounds and be powered with a 6-horsepower, 4-cycle engine. Cleated steel tractor wheels 24 inches in diameter will be used. The digging tool will consist of two steel spirals, tapering from 12 inches in diameter at the inner ends to 8 inches at the outside. Each spiral will be 11 inches long to give trench width of approximately 24 inches. They will rotate at a normal speed of 350 revolutions per minute in the opposite direction from the forward rotation of the tractor wheels. Chain and V-belt drive will be used on spirals and wheels. The machine will be controlled with a T handle and power will be used for steering. Forward speeds will be 1 to 5 miles per hour and reverse speeds one-half the forward speeds. Length of machine without handles, 37 inches; width 28 inches.

Firefog Unit.—See page 39.

Disk-Dozer.—See page 19.

Insulated Carton for Keeping Food Hot.—Regions 4 and 6 have used honey cans, in paper cartons, for dropping hot foods to fire fighters (Fire Control Notes, April 1946). Recently Region 6 located an insulated carton which apparently will be satisfactory without the use of a can. It consists of an A-flute corrugated box with special cut flaps and an insulated and water-proofed liner. This type container, in 1- to 60-quart sizes, is in commercial production. The 10-quart size, 10½ by 10½ by 14 inches costs about 27 cents each in lots of 1,000. Food will be put into cold storage locker containers, which are available in sizes up to 1 gallon, as it cannot, of course, be put directly into the carton.

Fire Finder Map.—For many years Region 6 mounted fire finder maps on metal, using the method described in the Fire Control Equipment Handbook. During the past 2 years experiments have been made with maps pressed between two sheets of plastic material. Ad-

vantages of this type of mounting are obvious. The trouble has been the tendency of the plastic material to warp. Last fall, a map was pressed between sheets of Vinylite, and exposed on the roof of a building from October 1 to January 1. At the end of the period, it had not buckled nor showed signs of deterioration. A few disks of this material will be tested on lookouts in the 1948 season. The cost will be about $6, but it is expected that a lower price could be obtained on quantity bids.

REGION 7

Pressure-Type Back-Pack Can and Pump.—This project was assigned in 1945. The object was to work with the D. B. Smith Co. in developing a back-pack pump outfit which would conserve water by delivering a continuous stream with greater accuracy, be dependable and simple to operate, and be reasonably free from mechanical defects. Three possibilities for developing pressure were considered: By mechanical means in a cylinder, by mechanical means in the tank, and by pressure cartridge. The first method was selected. Three units were field tested in 1946, in Regions 7, 8, and 9. Reports were considered sufficiently favorable to warrant more extensive tests, and 10 units were distributed in the spring of 1947 to Regions 1 to 6, inclusive.

The can is well constructed of galvanized steel. It has a cylinder in one side, into which water is forced with a pump. A hose leads from the top of the cylinder to a trigger-type shut-off nozzle. In use the operator holds the nozzle in one hand and operates the pump lever with the other.

A summary of regional reports lists two advantages, as compared with the "trombone" pump and can: (1) Better direction and accuracy of stream, which conserves water, and (2) greater compactness, requiring less space in shipment and transportation to the job. Disadvantages reported are (1) too heavy, (2) operation is fatiguing, (3) in operation, the can twists and hurts the back and (4) the handle is hard to disengage from the catch. Another disadvantage in going through thick timber or brush is that, in the carrying position, the movable cylinder extends several inches above the can and may catch on limbs. It was also mentioned that the pump sucks air when the water in the can is below the 2-gallon level.

Suggestions for improvement were to reduce weight by reducing tank capacity and using light metal, to reduce diameter of cylinder, to redesign pump lever and provide some means of preventing the twisting and "sawing" of the can on the back, to use a noncorrosive ball valve, to provide heavier shoulder straps with a carrying clip for nozzle, and to provide a handier pump lever clip.

Insulated Food Container.—This was an investigation of a container used in New England for transportation of fish and lobsters. Its dimensions are 14 by 14 by 26 inches, and the capacity is 40 to 50 pounds of live lobsters, 80 pounds of lobster meat, or 100 pounds of fish. A dry ice unit, 6 by 6 by 12 inches is claimed to hold temperatures from 50° to 20° F. Temperature is controlled by regulating CO_2 pressure. Three pounds of dry ice is necessary for a 24-hour period. Latest price quoted is $1.50 each. This container is not being manufactured at the present time.

Fire Control Tower.—The State of Maine purchased from WAA for $200, 102 feet, or two units, cataloged as "The Wayne Steel Portable Tower for Observation and Triangulation, type B." The steel was purchased for three 34-foot towers, with 8- by 8-foot cab. One has been erected at a total cost of $425. The sides have no batter. The tower is anchored in 14- by 14-inch concrete blocks and secured with ¾-inch cables 65 feet long. An inside stairway was substituted for the standard iron-rung ladder and a trap door was constructed in the roof for safety in making repairs. The tower is capable of supporting a load of 44,000 pounds.

REGION 8

Mathis Plow.—Produced by Mathis Machine Works. This is a 3,300-pound plow, with rolling coulter, middlebuster, and disks. It has been used for some time in areas where a light plow is not adequate. The lift is operated from a power take-off on the tractor. The plow requires a tractor in the D-4 class.

Husky Plow.—Used in Texas. It is a one-man fire fighting outfit consisting of a Husky garden tractor and a wide-angle middlebuster plow. It travels 3½ miles per hour and makes a 36-inch shallow trench.

Hi-Low Trailer.—Built to haul the Mathis plow and tractor. The capacity is 9 tons. It was fabricated from the back end of a truck at a cost of $800 in the Forest Service shop. A folding ramp proved unsatisfactory, so a sliding ramp was constructed. This is on rollers and can be moved by one man.

Tilt-Bed Trailer.—Constructed to haul the HG tractor and Ranger's Pal Plow, so as to save transportation equipment. It has tandem axles and single 7:00 x 16 tires. The axles and wheels are house-trailer type, with Corson coil springs to eliminate side sway. The brakes are electric. The Army pintle hook hitch is used. Cost of the trailer is $600.

REGION 9

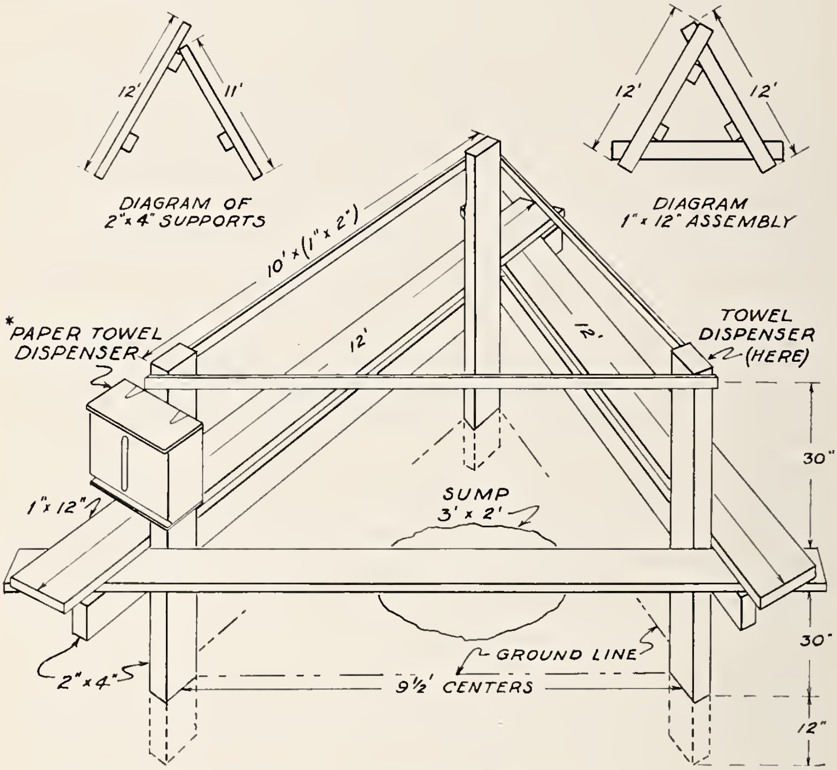
Stubby Plow.—This plow is described in Fire Control Notes, April and July 1947. It is a low cost double-bottom plow, which rides close to the tractor and folds compactly for roading. The bottoms are standard manufacture. The complete plow weighs 255 pounds and can be pulled with a light tractor. It has proved very successful and its use has stimulated interest in mechanized fire-control equipment. Construction of 45 of these plows is now in progress.

Smoke Masks and Goggles.—In testing numerous kinds of smoke masks, it was found that the hospital gauze mask was as good as specially designed smoke masks. Water must be available to keep the mask moist. Goggles with double glass were found to be little better than those with single glass. Each individual should have his own goggles and smoke mask for sanitary reasons.

Rotary Broom Rake.—The Gravely tractor and rotary broom was experimented with for line construction in hardwood leaves. The broom proved to be too long and was shortened, but still consumed too much power and was not very satisfactory. A 20-inch disk with spring tines, such as are used on the International hay bailer, has been constructed but not yet tested. It is expected to require less power than the broom, so that the 5-horsepower Gravely tractor will be adequate at a speed of 2 miles per hour.

Fire Camp Wash Rack.—The wash rack as shown in the diagram has been used successfully and will in most cases eliminate the sloppy conditions which will develop where fire fighters have to wash up.

The installation provides (1) a sump to dispose of waste water; (2) a bench of convenient height for wash basins; (3) rails to support towels, mirrors, etc.; (4) paper towel dispenser (folding, or roll type optional); (5) large cartons or GI cans for waste paper. The paper towel dispenser recommended is the one designed and used by the Plumas National Forest and which holds four to six packages of folded paper towels at a time. Two or more such dispensers are needed per rack.



It will be instantly noted by camp bosses and others concerned with the need for a wash rack, that it can be constructed by using native materials or whatever is at hand. Size, shape, and material specification will make little difference as long as the five functional elements listed above are provided.

The use of slotted strap iron hangers fastened to the bench boards and so designed to slip onto fixed studs set in the posts will do away with the 2- by 4-inch rail supports and provide a permanent and portable rack which can be used repeatedly.—K. McDonald, *Fire Control Officer, Tahoe National Forest, Calif.*

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustration. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.

The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually following the first reference to the illustration.

VOL. 9 OCTOBER 1948 No. 4

FIRE CONTROL NOTES

A PERIODICAL DEVOTED TO THE TECHNIQUE OF FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 9 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

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Contents

LIGHTNING FIRE DISCOVERY TIME ON NATIONAL FORESTS IN OREGON AND WASHINGTON

William G. Morris

Pacific Northwest Forest & Range Experiment Station
U. S. Forest Service

In Oregon and Washington lightning causes 25 percent of the fires on State and private lands and 70 percent of those on national forests where more rugged topography favors lightning-storm development. Although many of these fires occur with rain and are quickly seen and easily suppressed, others cause great damage by smouldering unseen until dry, windy weather suddenly fans them to life in bad fuel types. Knowledge of the experience records of lightning fire discovery times is useful in planning for the load on suppression forces or the period during which extra lookouts and aerial patrols may be productive after a lightning storm.

Several circumstances may affect the discovery of lightning fires. For example, when a bolt of lightning strikes it may hit dry fuel from which flame or smoke may be visible almost at once. On the other hand, it may hit wet fuel which may smoulder for a week or more before becoming dry enough for the fire to gather headway and produce visible flame or smoke. The strike may be in an open forest cover where smoke near the ground can be easily seen or it may be in a tall, dense cover where diffused smoke is hidden until it becomes too thin to be noticed when it finally reaches above the trees.

One source of information concerning lightning fire discovery times is the individual fire report of the national forests. These reports show the time of ignition of each fire as judged from records of the time when the lightning storm passed over the area. They also show the time when the fire was first discovered. Reports for 5,300 lightning fires on the national forests of Region 6 [1] during the period 1940–44 were tabulated according to the locality and timber type in which each occurred and the interval between ignition and discovery.

The average percent of fires discovered at various time intervals after the storm occurred is shown in figure 1 and table 1 for Region 6 as a whole. If 1-hour rather than 2-hour periods had been illustrated, the chart would show that 31.2 percent of the fires were discovered in

[1] Washington and Oregon, excepting the Colville National Forest in northeastern Washington which is in another administrative region. The Olympic and Siuslaw National Forests of the Coast Ranges in Region 6 were omitted because they have very few lightning fires.

the first hour after the storm. The fires remaining to be discovered after 8 days, the limit of the chart, were 3.5 percent of the total number.

TABLE 1.—*Proportion of lightning fires discovered within various periods of elapsed time after ignition, Region 6, 1940–44*

Periods of elapsed time	Percent of total fires
6 hours	50
24 hours	78
3 days	90
7 days	96

Figure 1 shows a decreasing rate of discovery until 8 hours after the storm, then a gradual increase until 16 hours, then a decrease until 32 hours, then an increase until about 42 hours, then a decrease. Both high points occur 8 to 10 hours after the low points. The low points are 24 hours apart, and the high points are at nearly the same interval. No satisfactory explanation of this pattern has so far been found. Since burning conditions and visibility vary with the time of day, the pattern may be related to the proportion of storms beginning at different hours. In such a case, the elapsed discovery times would have to be analyzed according to the hour at which the storm occurred in order to recognize the relationship.

EFFECT OF COVER TYPE

To learn which forest cover conditions may have contributed to differences in discovery time, the kind of cover at the starting point of each fire was classified as either an open canopy or a closed canopy. The discovery times in each class were studied to learn if fires starting in an open forest canopy are usually discovered more quickly than in a closed canopy. The open cover included nonrestocked cut-overs and old burns, small regeneration and saplings, and the ponderosa and lodgepole pine types. For the two States as a whole, discovery times for these types were less than for the closed types. Within 6 hours after the storms, 52 percent of the fires in the open types and 45 percent in the closed types had been discovered. This 7 percent difference remained nearly the same for any given elapsed time from 6 to 48 hours after the storm passed. As a result, 19 percent of the closed-canopy and only 11 percent of the open-canopy fires remained to be discovered after 48 hours.

VARIATION BY SUBREGION

Since there is a great difference in fuel and fire-weather conditions between northern and southern and eastern and western parts of the two States, the fire reports were grouped according to national forests that have similar conditions. The discovery times were then studied to determine if the results previously discussed for the two States as a whole differed appreciably between the forest groups. Part of the

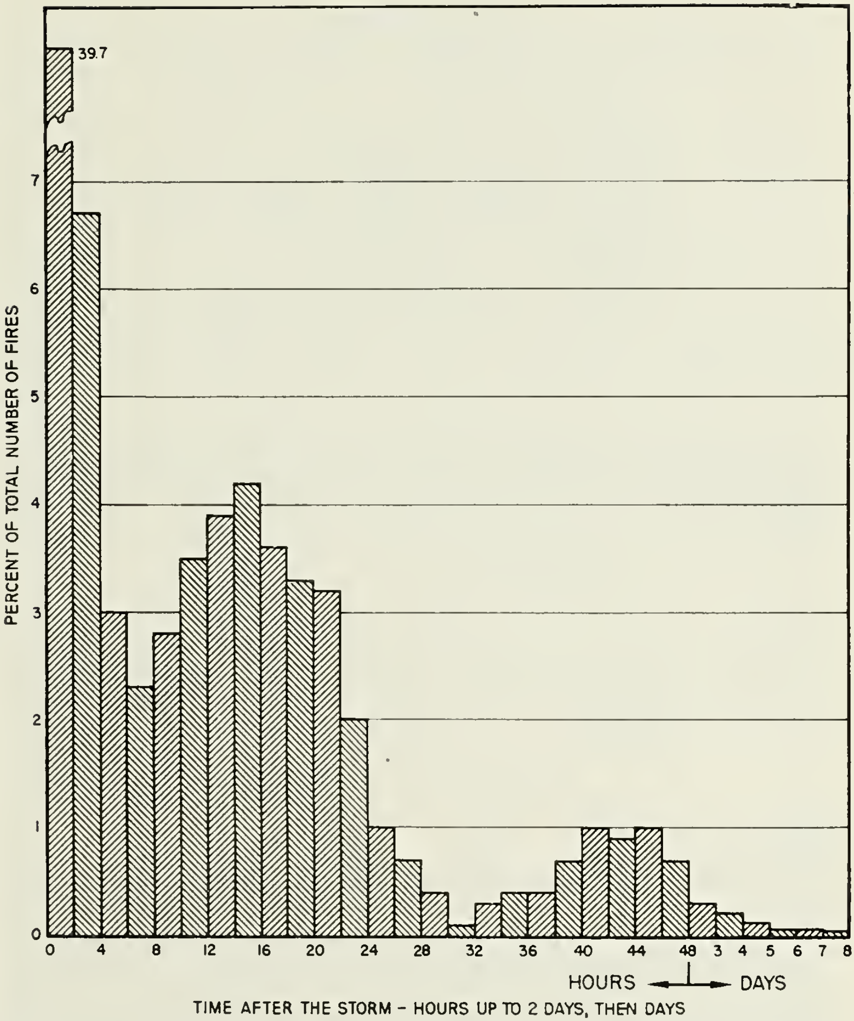

FIGURE 1.—Average rate of lightning-fire discovery at specified periods after storm occurred, for 5,357 fires in Region 6 during 1940–44.

data giving comparisons of the proportion of short and long discovery times in different forest groups is shown in tables 2 and 3.

Except in the Chelan-Wenatchee group, rate of discovery in each group followed a pattern similar to the regional pattern shown in figure 1.

The Mount Baker-Snoqualmie-Columbia group of western Washington discovered a much larger proportion of its fires than did the Oregon forests in the first 6 hours. By the end of 24 hours, however, the relationship was reversed and the Oregon forests had discovered as great or a greater proportion of their fires compared to the western Washington forests. The Chelan-Wenatchee group of eastern Washington discovered a greater proportion of its total fires than did any other group during each elapsed time period between1 hour and 7 days.

TABLE 2.—*Proportion of lightning fires discovered in each of the first 3 hours after ignition in different national forest groups in Oregon and Washington, 1940–44*

Hour	Washington		Oregon			
	Mount Baker, Snoqualmie, Columbia	Chelan, Wenatchee	Mount Hood, Willamette, Umpqua	Rogue River, Siskiyou	Deschutes, Fremont	Blue Mountain forests
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1st	46	46	28	25	23	23
2d	5	7	9	8	11	10
3d	3	3	4	7	6	4

TABLE 3.—*Proportion of lightning fires discovered within various periods of elapsed time after ignition in different national forest groups in Oregon and Washington, 1940–44*

Periods of elapsed time	Washington		Oregon			
	Mount Baker, Snoqualmie, Columbia	Chelan, Wenatchee	Mount Hood, Willamette, Umpqua	Rogue River, Siskiyou	Deschutes, Fremont	Blue Mountain forests
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
6 hours	59	63	45	44	45	42
24 hours	74	83	74	77	82	78
3 days	86	94	87	87	92	91
7 days	92	98	94	95	99	96

The effect of open and closed forest canopy types upon fire discovery time was studied by forest groups to determine if the effect noticed for the two States as a whole was consistent in all groups. The Washington and western Oregon groups showed the same tendency for earlier discovery in the open-canopy types as discussed previously for all groups combined. But in the eastern Oregon groups the proportion of discoveries during the first 6 hours was approximately the same in both closed- and open-canopy types. This is reasonable since most forests are somewhat open in eastern Oregon, making less contrast between the open and most dense timber types than in Washington or western Oregon. On the other hand, between 6 and 8 hours after the storm the proportion of discoveries increased in the open-canopy type in eastern Oregon. As a result, in the eastern Oregon forests, as in the others, a greater percentage of the fires occurring in open-canopy timber types than in closed types was discovered before 8, 24, or 48 hours had elapsed. This left a greater proportion of the fires in closed-canopy types to be discovered after 48 hours or more in all the forest groups.

CONCLUSIONS

Results of the lightning-fire-discovery-time tabulations indicate that the peak load of discoveries and reports is in the first hour after the lightning strikes. This should be kept in mind when planning for prompt discovery by emergency lookouts and airplane patrols and prompt attack by suppression crews, although weather and visibility are usually unsafe for flying during the first hour. About 50 percent of the fires are seen within 6 hours, 20 percent remain to be discovered after 24 hours, and 10 percent after 3 days. From this it appears that emergency lookouts, patrols, and suppression help may be needed for at least 3 days. The Washington forests have a greater proportion of their lightning-fire load in the first hour than do the Oregon forests. If all fires are to be suppressed as soon as possible after discovery, regardless of locality, emphasis on action as soon as the storm strikes is then even more important in Washington than in Oregon.

Lightning being the greatest cause of forest fires in mountainous parts of all the western States, the applicability of the above results to other western States besides Oregon and Washington should be considered. Results that were consistent in different forest groups within this Region may apply elsewhere and are as follows: (1) The general form of the discovery-time pattern in figure 1. (2) About 6 percent or more of the fires remain to be discovered more than 3 days after the storm passes. (3) In closed-canopy timber types a greater proportion of the fires than in open-canopy types remains undiscovered 48 hours after the storm. The proportion of fires discovered in each hour and within various periods of elapsed time up to 2 days is not likely to apply directly to other States because these proportions varied greatly within Oregon and Washington.

Paint for Rust.—In fire fighting, as in any work, a sharp, clean tool is the best and safest tool. Maintaining such a tool under the Region 8 conditions is a constant fight against rust. We have used oil, grease, and paint of various kinds. Usually the oils and grease are too messy and pick up dirt. The ordinary paint usually blunts and slows a sharp edge.

Until coming to the Francis Marion, I had seen no one method which completely protected and still maintained the full efficiency of the tool. We use Rust-oleum number 634, quick drying, black, on the dry blade immediately after it is sharpened and ready for use. This paint drys rapidly, keeps a good protective coat in storage, and is sufficiently brittle that on use of tool it immediately flakes off leaving a sharp, clean tool.—George K. Schaeffer, *Ranger, Francis Marion National Forest.*

HOW TO MEET THE HUNTER

O. L. "Lute" Mullenax

Fire Control Aide, Monongahela National Forest, West Virginia

Fire Control Aide O. L. Mollenax at a fall fire prevention meeting on the Monongahela National Forest was assigned the subject "How to Meet the Hunter." His presentation of the subject received the hearty approval of the rangers, general district assistants and fire control aides present. The group immediately suggested his talk be reproduced in Fire Control Notes.

Some readers may feel this article presents elementary principles already practiced by everyone in the Forest Service who has occasion to contact people. However, if it does no more than assure doubtful readers, especially new employees, that this is the Forest Service way, it will be worth presenting.

"Lute" Mullenax is one of the veterans on the Monongahela, having worked intermittently on the Greenbrier District since its beginning in 1926. Naturally gifted with the knack of making and keeping friends, and a type who is very valuable in on-the-ground public relations work, he is well qualified to speak on everyday public contacts.

Putting yourself in the other fellow's place is a pretty good rule when you are trying to figure out a course of conduct. In other words, I'll suppose that I am the hunter. I want to be treated with respect and courtesy when I come into the national forest on lawful business. After all, I can say that you fellows are kind of working for me. To be serious, I feel that I am entitled to respect, courtesy, and consideration. Really, I am a guest of the Forest Service. If you come to my home, it is my duty to welcome you and try to make you feel at home. Don't you think that a forest officer should approach a hunter on this basis?

On the other hand, we as forest officers have certain things which should be understood and accepted by the hunter. For example, last spring (and the fact that it was a fisherman rather than a hunter should make no difference) I encountered a fisherman camping on Little River on the plantation side of Little River Truck Trail. Here was a situation which called for some action. The fire was built in a prohibited area. The camper was having breakfast. I greeted the fellow, identified myself, inquired about his luck and "batted the breeze" for probably 5 minutes. I then asked him if he had a camp fire permit. He said, "sure," and presented it without further urge. I noted that the permit stated that the location of the camp fire would be on Little River south of Middle Mountain Truck Trail. Actually the camper was right but I had to get his fire across the road from the plantation. I explained to him that the permit meant that the fire would be built between Little River and Little River Truck Trail. He was apologetic and offered to put the fire out right away. I told him to finish breakfast and then we'd put the fire out. He could build his noonday fire below the road. Incidentally, I enjoyed a cup of coffee with him. I left this man with the feeling that we'd enjoyed each other's company and were friends. This, I think, is the test of a good contact; gaining your point and also a friend.

Here are the rules I would set down for meeting the hunter:

1. Meet the hunter with a smile, not a growl.
2. Let him know who you are.
3. Give him the impression that you are interested in his sport and welfare and want him to enjoy himself. In other words, you are glad that he is there.
4. Try to be helpful to him rather than a nuisance.
5. Don't go into lectures or instructions or preaching unless the circumstances indicate the need. In other words, if he has built a fire properly in a safe place, compliment him, don't go preaching about how to build fires in safe spots.
6. Steer him our way rather than try to order him around or regiment him.
7. Don't impose yourself on the man. There are times when you can sit down and have a nice long visit but there is also a time when he is anxious to get to his hunting. This is a matter of judgment.
8. As soon as you leave you'll know whether you have both gained your point and gained a friend. If you are not sure, figure out how you could have made the contact better.

Operator Training.—Recognizing the need of operator training, the Divisions of Personnel Management, Fire Control, and Engineering in Region 5 have inaugurated an operator training program during the past year. Driver trainers who are skilled in equipment operation and safety are furnished through the Equipment Service Section of Engineering on a request basis to the various forests.

Each operator is given a driver's safety examination which consists of questions taken from the R–5 safety examination with some pertinent questions added. In addition to the written examination, the operator is put through a series of tests to show physical aptitude including foot reaction, field of vision, and depth of vision. He also participates in the oral examination and discussion covering driving rules, courtesy of the road, etc. Finally he is given an actual field test driving the type of vehicle for which he is being qualified.

A record is kept, not only of examination grades made by equipment operators, but notes are also made regarding reaction, vision, and results of the driving tests. All such records are turned over to the operator's superior officer with notations as to whether the operator should have more training, is qualified to drive, or has been disqualified and for what reason.

Special instructions and tests are given to operators driving specialized equipment such as fire tankers, pumpers, and tractors. After the original or first-of-the-season training schedule has been completed, the driver trainer concentrates on follow-up training of tanker operators not only in the operation of the unit but also in the care, lubrication, maintenance, testing, and adjusting of machines insofar as the particular operator is capable.

In facilitating the driver-trainer program, the chief driver trainer also certifies qualified personnel on the various forests as on-the-job driver trainers to take care of on-the-job testing of new personnel or replacements. The chief driver trainer on follow-up trips checks the qualifications of new operators when requested or the occasion and circumstances demand.

Whereas, this program was originally designed and justified on the basis of safety, it has been found very beneficial from a standpoint of obtaining proper use and care of automotive equipment and probably could be justified on the basis of its effect in lowering the maintenance costs of that equipment.—D. W. McFarland, *Area Superintendent, Arcadia Equipment Depot, Region 5, U. S. Forest Service.*

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HEADFIRES ARE COOLER NEAR THE GROUND THAN BACKFIRES

A. W. Lindenmuth, Jr., *forester*, and George M. Byram, *physicist*, *Fire Research, Southeastern Forest Experiment Station*

Temperature measurements of fires burning with and against the wind in the longleaf pine type on the Francis Marion National Forest in South Carolina indicate that headfires create cooler temperatures near the ground than backfires. This difference is important in the management of longleaf pine, because seedlings infected with the brownspot needle disease must be burned before they will start to put on height growth. These seedlings are usually in "the grass stage," less than 6 inches high. They will remain that size and virtually starve to death unless the infected needles are burned off. Thus, in a longleaf burn, attention is focused close to the ground. In contrast with burns in other species, fire in longleaf is expected to benefit, rather than kill, the seedlings.

To facilitate prescribed burning in longleaf, fire intensity measurements in the low zone were commenced in May. Because liquid thermometers cannot measure flame temperatures that run as high as 1,500° F., thermocouples were used. These were designed to integrate the effect both of temperature and its duration. This combined effect (in other words, the thermocouple reading) may be called the heat factor. It tends to be lower than the actual temperature, but rises with the length of exposure. This rise in temperature of vegetation will be proportional to the heat factor, the exact proportion varying with the size of the vegetation. It is this heat factor that determines the amount of scorching, leaf consumption, and mortality.

Observations shown graphically in figure 1 indicate that the maximum heat factor varies in the proportion of 1.25 for backfires to 1.00 for headfires. Also, maximum heat factor in both types of fires is reached at about 5 inches above the ground. Up to some 18 inches above ground, the heat factor of backfires continues to be higher than that of headfires. Beyond this point, as shown in the figure, the heat factor of headfires is higher. The actual point where the curves cross is at present tentative, and further field work may shift the location significantly.

The reasons for the heat factor differences in the two types of fire are unknown and probably complex. Both convectional and radiant heat are involved. A partial answer, supported by visual observations only, may be that in headfires combustion occurs at a higher level above the ground and that the fire line advances considerably faster.

The value of these tentative results will be tested in field trials. Ranger Koen, Fire and Improvement Unit, Francis Marion National Forest, who had anticipated the results, is carrying out a planned

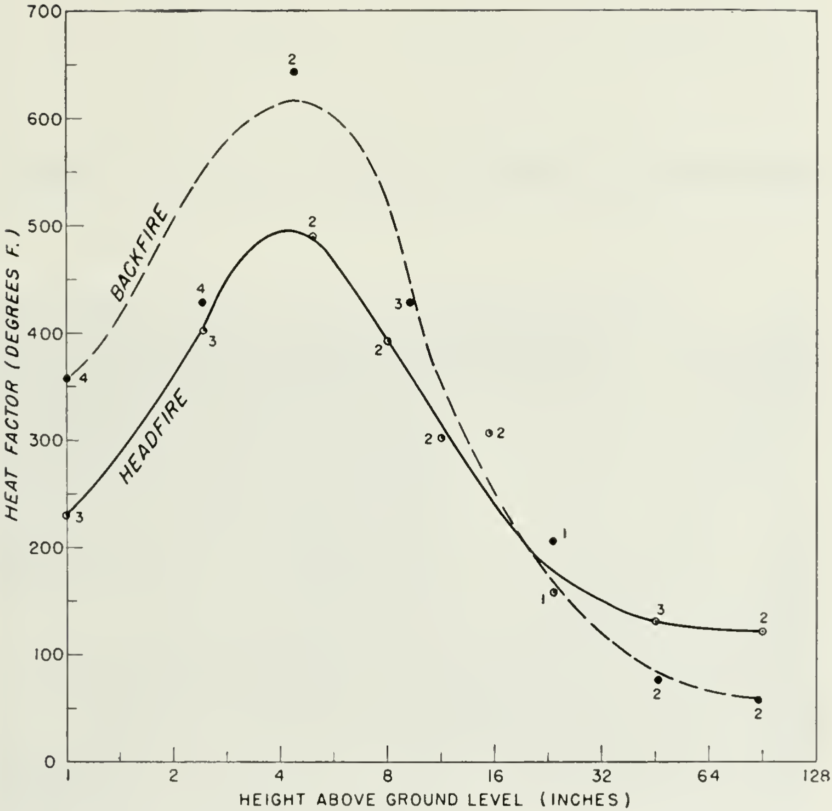

FIGURE 1.—A comparison of the heat factor associated with backfires and headfires, as measured at varying heights above ground level. Actual flame temperature is approximately 1,500° F.

burning program on a small scale to find out what use can be made of the information. In prescribed burning where it is desired to minimize damage to reproduction under 18 inches or so in height, headfires may prove more economical and effective than the backfires now so commonly used.

DROPPING SUPPLIES FROM SMALL PLANES

DEAN FIELD, *Pilot, Western Washington Aircraft, Inc., and* HUBERT O. WILSON, *Fire Staff Assistant, Mt. Baker National Forest*

We thought larger planes carrying a dropper were necessary in past years when supplies were dropped on fires; however, there are few ships of this size at the small airports that are available for our use. Two-place planes, with the pilot doing his own dropping, have been used with much success for servicing fire crews and lookouts on the rugged Mt. Baker National Forest. The small ships can maneuver in a smaller space and get down over small meadows in the valleys where a larger plane cannot. They have a slower cruising speed; therefore, it is easier to drop packages close to target.

Using only a pilot, we dropped 20,610 pounds of supplies in 1946 and 1947 from small planes. An average of five 40-pound packages were dropped each trip.

Dropping procedure for the pilot.—After dropping a package on the target, climb for a little altitude toward an open area so that you will not have to bother with flying the plane to any extent during preparation for next drop. Pull in the static line and tie to the rope ring of the next package to be dropped. Pull the package up over your shoulder and onto your lap, then ease the bottom of the package to the door and hold package by the top (fig. 1). When package is far enough out so that it is just tipped outward yet resting on door frame, it can then be held easily with the door frame supporting the weight, yet a slight push will send it down. Check the static line to insure its being free of rudder bar, stick, and other controls. When plane is in proper position, speed, and altitude over target, tip the bundle over the door frame and let it fall. Usually pull up and turn sharply so as to view the bundle falling to see if any change of timing is necessary for accuracy.

Safety factors.—Use clean sacks so that dust or other particles will not get into the pilot's eyes.

See that the static line is not fouled before dropping package.

Carry a knife to cut static line if necessary.

Fly another round if you are not in position to drop accurately; lost food does not help the fire fighters.

Keep tail high when package is dropped, throttle slightly retarded and maintain cruising speed by slight glide. Do not dive on target.

The food and supplies are packaged in a regular burlap feed sack, with a 13-inch-diameter disk of ¼-inch plywood in the bottom. A 7- by 7-foot burlap chute, with the shroud lines tied to the top of the sack by a square knot, is used. The chute is rolled with the shroud lines inside and tied with a 20-pound-test string to hold the chute roll.

These strings are sewed through the package sack with a sack needle and tied around the end of the chute roll. The string is passed through a rope ring (Molly-Hogan). A second string is sewed through package and tied around the other end of the chute, also going through the ring before tying. The static line that is fastened to the seat strut is tied to the rope ring. When the package is dropped, the rope ring breaks these string fastenings and pulls the chute out and open by another short string that is sewed to the chute apex and tied to rope ring. The package and chute float down leaving the rope ring on the static line.

FIGURE 1.—Dropping procedure: Upper, package and chute pulled from back seat; sack placed on door sill with chute inside plane; lower, package pushed out and downward as slip stream catches it.

AERIAL DETECTION ON THE SUPERIOR NATIONAL FOREST

J. W. TRYGG
District Ranger, Superior National Forest

As we look back some 18 or 19 years, it is easy to see how inadequate our basic fire organization really was compared to our present day system. It was only a few years ago on the Superior National Forest, when the spotting and locating of fires through the eyes of the lookouts seemed to be perfection in fire detection.

The dispatcher at the district headquarters, acting largely upon his experience and intuition of how "bad" the day was to be, would line up the usual initial attack crew of 10 men equipped with hand tools and food supplies. When a fire was reported by a lookout, either by direct or relayed telephone message, the crew would start on its way, traveling by truck, boats, canoes, and on foot. A day or more was often spent in finding the fire. All this time, the fire burned on. As it grew, more reports were received from the lookouts and more men were dispatched only the disappear in the silence of the forest just as the first crew had done. No one at headquarters knew where the fire fighters were or what they needed.

Following World War I, flying became a pastime and private seagoing planes appeared on the lakes of the Superior. By 1929 it was possible to hire private planes to reach the otherwise inaccessible back country of the Forest. About this time the Forest Service realized the practicability of using planes for fire reconnaissance and during the next 6 years this practice was followed. The value of planes in fire work is indicated in the following narrative from the writer's personal experience some years ago:

As the lookout watched he saw a seaplane go by on its way to locate a smoke he had reported about an hour ago. In a few minutes the plane was returning the ranger and his smokechaser to headquarters with complete information about the fire. As the fire was already running, the ranger decided to send the smokechaser back to the fire with a pump operator, pump, and 800 feet of hose. The ranger felt much relieved at his action, yet he wondered if enough hose and men to handle the pump unit had been sent. If not—there wasn't room in the plane for more men and equipment—he knew it would take less than an hour for the pilot to return to headquarters for an extra trip.

The plane took off. After arriving at the fire the pilot had to help set up the pump and string out the hose. Within 15 minutes the head of the fire was stopped and the pilot was on his way back to the ranger station for additional help.

On the way back to the fire with three more men, two other fires that the lookouts had not seen were spotted. When the plane landed, the pilot reported the fires to the smokechaser. As the first fire was under control, the pump operator and one man were left to mop up and patrol. The pilot put his plane down on a small lake since one of the two new fires was only 100 feet from the shore. After leaving his last two men on this fire the smokechaser was piloted over the third fire which was about a mile away. This fire proved to be a lightning strike in a

dry snag, and since there had been no rain with the lightning it might cause trouble. Knowing that the ranger had left his station to direct a 20-man crew overland to the first fire and also that all reserve manpower on the district had been dispatched to a large fire on an adjacent district, the smokechaser landed, walked across country for a mile, and alone extinguished the burning snag.

Through this and several similar incidents the Forest realized the use to which airplanes could be put in fire detection and suppression and in 1934 hired its first amphibian-type contract plane. This plane did not prove satisfactory. From 1935 to 1939 the Forest used a pontoon-equipped 4-place Stinson. While the Stinson proved to be a very good all around craft and satisfactory for initial action on small fires, it was not adequate for heavy cargo service.

In 1941 a Piper Cub was purchased and equipped with pontoons. In 1944, because the Stinson had been totally wrecked in a take-off accident, an 8-place Noorduyn-Norseman pontoon plane was purchased. This solved the cargo problem. The larger plane has worked out very satisfactorily as a capacity cargo transport and withstands the rigorous landings on rough waters.

The results of fire detection through the use of these planes led to the proposal of a detection experiment. The specific purpose of this experiment was to determine first, how effective aerial detection would be compared to that of regular lookouts, and second whether towers could be replaced entirely or whether a combination of the two systems should be used. The experimental detection was started in July 1945, and, with some changes, is still continuing.

In planning the use of aircraft for detection patrols, recognition should be given the elements that may disrupt the schedule of flying or affect visibility. These elements could well be listed as follows:

DISRUPTING ELEMENTS

Rough flying weather which taxes the physical stamina of the pilot and observer.

High winds causing exceptionally rough water on landing areas.

Time used for mapping a fire when located, and intensive checking of certain areas because of concentration of forest travelers, lightning storms, or other special risks.

ELEMENTS AFFECTING VISIBILITY

Reflected light on smoke, depending on overcast sky or shadows.

Position of sun. A wider coverage can be patterned when observation is toward sun.

Confusing haze with smoke.

Color of background.

Time of day. Evening glare and shadows.

Effect of wind on smoke rising above tree tops. Smoke is difficult to see when plane is directly over it.

Speed of plane.

The experimental detection area embraces approximately 1,000,000 acres. This area was previously covered by eight primary Forest Service towers as well as one Canadian tower and three State towers manned infrequently. The direct seen-area coverage from all these towers was less than 25 percent. A seen-area study that had been previously made indicated the need for 6 more primary towers, plus a large number of secondary points for periods of low visibility to get less than 40 percent coverage. Instead of constructing these additional installations, aerial detection was immediately instituted as the pri-

mary detection system and the existing towers retained as supplementary.

We now own three pontoon planes and have two regular pilots to fly them for the particular type of service desired. Flight circuits are predetermined to obtain an established pattern of coverage. The smallest plane, a 2-place Cub Coupe, is largely used for detection patrol, and is routed over the shorter circuit so that it can return within a short time. A 4-place Seabee is scheduled for the longer circuit. The third plane, an 8-place Norseman cargo craft, is used when it is necessary to fly initial attack crews and cargo to fires. The aerial service is further augmented by employing private aircraft for emergencies or whenever the Forest Service planes cannot handle the full task of aerial detection and suppression transport.

A number of conclusions have been reached as a result of the experiment.

Aerial detection is superior and more efficient than fixed towers in all cases where fires will remain in an incipient stage to allow for less frequency of detection. A sizeable degree of risk may also be allowed since an aircraft will provide more complete and accurate information upon which to base suppression action.

Fixed towers give more continuous coverage at more frequent intervals. In aerial detection this loss in frequency of detection is offset by the more complete direct seen-area coverage which makes possible earlier discovery after a fire occurs in flash fuel types.

Fixed towers have a pattern of detection time over high risk areas. Aerial detection offsets this because it is sufficiently flexible to allow for more frequent coverage. Furthermore, aerial detection is adjustable to cover changes in these risk areas within seasons and year-to-year changes in fire occurrence zones.

Fixed towers have a distinct advantage in immediately detecting fast starting fires in light flash fuels or slash areas. Under such conditions aerial detection will have to supplement these towers during periods of low visibility.

Since the pontoon-equipped plane serves as a type of watercraft, it immediately replaces the expensive power boats previously considered essential for travel over large bodies of water. Likewise, the number of other watercraft normally used for transporting crews to and from fires for other fire control work can no doubt be reduced to a minimum. The same situation has developed for other equipment, particularly in outlying fire tool caches.

Greater efficiency can also be accomplished in providing supplies, food, and materials for suppression crews.

In comparison, the direct cash outlay for airplane detection shows a substantial saving over the old method of tower detection and all that went with it.

In regard to whether or not towers could be entirely replaced or a combination of fixed and flying detection should be used, the following seems pertinent: Our experimental detection project has been operating on the basis of using aircraft as the primary detectors, while lookouts have served to supplement them. A failure in carrying out the schedule of flights and obtaining sufficient frequence in detection coverage obviously weakens the system. The manning of towers in key locations in areas of high risk, as well as where broad extensive

coverage can also be made, serves well to offset the risks that may be prevalent when aircraft are not in flight. This has been resorted to during periods of high hazard. Such a system can be justified when a high frequency fire occurrence may be patterned within the seen-area field of the towers. Otherwise there is a duplication of detection unless areas covered by the tower are eliminated from the aerial zone.

In addition to all that has been revealed by the experiment, we have found that positive and reliable radio communication is absolutely essential to efficient detection service. Without such communication we lose all the advantage that has been gained through fast discovery by air. It is further essential that the central dispatcher or base of operations responsible for directing patrols maintain up-to-the-minute information from the observer and to correlate other flying needs.

Also, the basic qualifications and adeptness of an observer must be previously ascertained. His age and physical make-up will determine his ability to perform under all conditions, especially those of unusual physical strain that are frequently encountered. He must have good eyesight. He should preferably have had flying experience so that he has a proper perception of things he has to recognize from the air. A knowledge of the general formation of terrain, timber, and forest fuel types is essential. He should also be able to read maps, interpret aerial photographs, calculate the size of fires, and understand the operation and maintenance of a radio set.

As for the pilot, he must know from experience the comparative limitations he is up against because of the variety of situations and flying conditions. The operational problems of landing and basing aircraft on the waterways of the Superior region are unique in themselves. Each lake used as a landing base has its own peculiarities such as the effect of air pressures, and wind currents. The effect of wind on the water surface makes landings and take-offs uncertain at all times. The characteristic geological formation of rocky irregular shore lines and the elevations of surrounding hills and timber create major problems in landing on an unobstructed and safe flying strip. In short, the pilot must have "bush-born" experience with pontoon-equipped planes if he is to operate safely over the Superior country.

What the future holds for detection and suppression from the air is not all imaginary. The possibilities of the helicopter have already been proven. Fire fighters dropped from the air have passed the pioneering trials. Radio communication is being constantly improved. Water bombing and dry-iced rain are in the experimental stages. We might, however, well imagine future fire control fields involving radar detection and fire observance through televised portrayal. I wonder if 18 years from now we will think of our present detection system as antiquated as our present knowledge tells us our system of 18 years ago really was. Only time will tell.

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TRACTOR MUD TONGS

Fred G. Ames
District Ranger, De Soto National Forest

The tractor mud tongs were developed on the Chickasawhay District to help fire plow tractors, mired during fire line construction, out of bogs and marshy places.

The mud tongs, developed for HG Cletrac tractors, are used in sets of two, one for each track, and a set is carried on each tractor as part of its standard equipment. They are easily put on and taken off the track shoes.

A tong consists of two hooks, each made of ⅜- by 3½-inch flat iron and curved at one end to form a short flange, connected with about 2½ feet of ⅜-inch log chain (fig. 1).

A short distance from each hook a cold shut connects the chain so that a loop is formed in the chain. The cold shut serves to hold the hooks in place on the track shoe. It should be at such a place on the

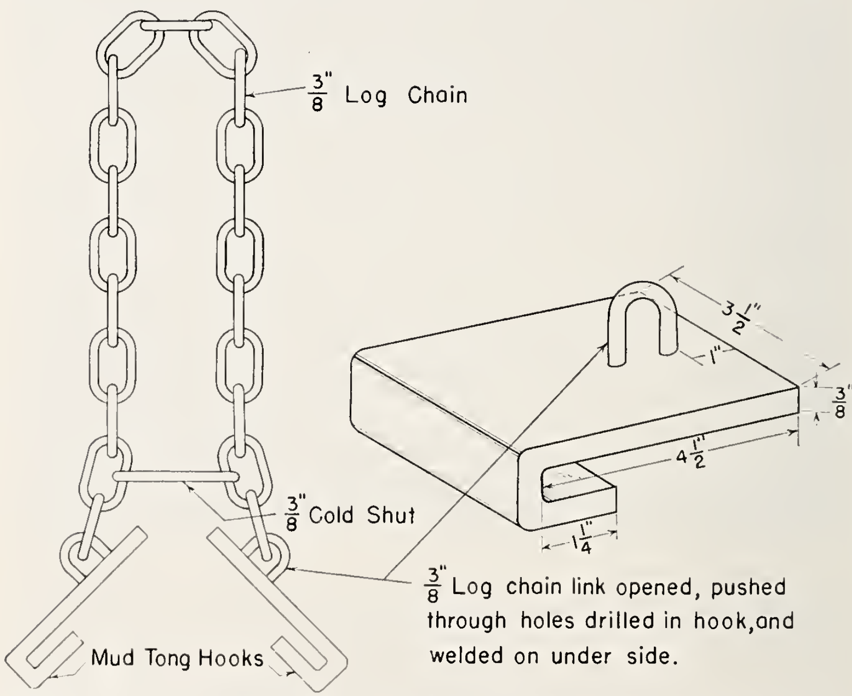


Figure 1.—Tractor mud tong. Log chain loop should have an odd number of links so that loop will not have a twist.

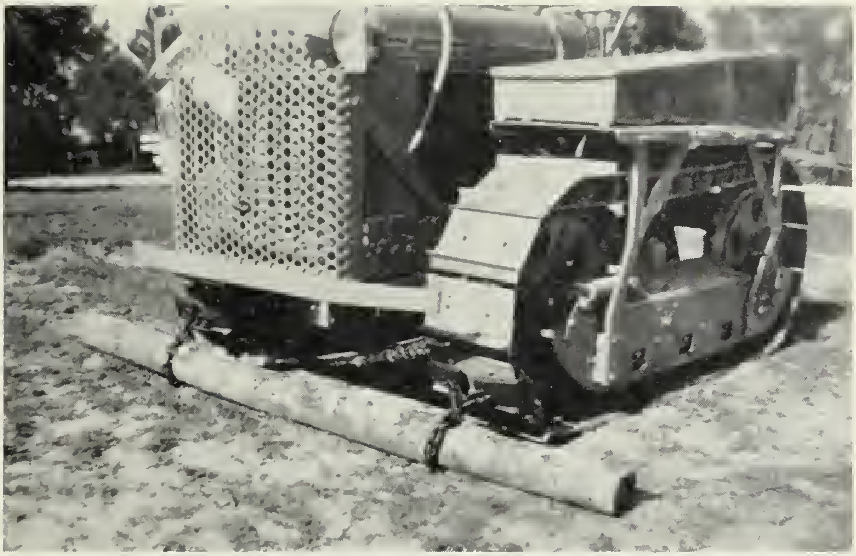


FIGURE 2.—Tongs in place with pole through chain loops.

chain that when the hooks are spread they will barely slip over the track shoe.

When the tractor mud tongs are attached to the tracks and a pole run through the chain loops, the tractor can be made to ride itself up on the pole and out of the mire (fig. 2). This method of riding a mired tractor out of mud is not new. But by use of these mud tongs much less time is consumed than by the use of the conventional pole and chain.

Why Tote a Back-Pack Pump.—Experimentation with a hand pump taken from a back-pack outfit, attached with fittings to a ½-inch garden hose 25 feet in length, the other end of which is attached to a valve fitted into a 50-gallon drum filled with water, proved that where a power pump is unavailable hand pump pressure can do a fairly good job of water dispersion.

For patrolmen or firemen pick-ups and jeeps, a 50-gallon drum of water secured in the bed, a 50-foot coil of garden hose, and a hand pump make action on small accessible fires convenient. A good supply of water is available and more freedom of motion is allowed.

With the 25-foot hose, the hand pump worked as efficiently 12 feet above the source of water supply as on the ground.—ELMER F. PETERSEN, *District Ranger, Sequoia National Forest.*

FUEL MOISTURE STICKS ARE ACCURATE

A. W. Lindenmuth, Jr., *Forester, Fire Research, Southeastern Forest Experiment Station*, and J. J. Keetch, *Danger Station Inspector, Region 7, U. S. Forest Service*

Occasionally man's "better judgment" causes him to doubt the contributions of the devices or techniques now a part of our present civilization. Distrusting the compass when lost, for instance, is a good example. Such lack of confidence is not necessarily confined to the novice. It occurs from time to time also among the experienced, particularly in uncommon situations.

A system of fire danger measurement using Appalachian or slat type fuel moisture indicator sticks is a commonly accepted technique in use in the East and South from Maine to Texas. It is almost inevitable that sometimes under such a wide range of conditions the indications of the sticks at one or more of the 414 stations will conflict with the judgment of the observer or fire control officer. As complete confidence in the observations is essential for effective use of danger measurements, such doubts should be cleared up as soon as possible. The fire control officer wants to know that on a day like last April 18, when the moisture content indicated by the sticks varied less than one percent between Airey Tower on the Gulf in Mississippi and Ossippee Hill down East in Maine, that the effect of all the factors influencing fuel moisture content at those widely separated stations at that particular time was the same.

The fact is that the behavior of any single set of sticks compares and can be checked with an average of many sets. Curves showing the average effect of the two major variables of temperature and moisture content of the air provide a handy yardstick for this purpose. Such curves are available for limited conditions and a portion of them are reproduced here (fig. 1).

Strictly speaking, the temperature used should be an average of that of the upper and lower surfaces of the sticks. However, to avoid technical difficulties, an acceptable estimate can be obtained by exposing a regular mercury thermometer on top of the sticks for about 5 minutes. The result might be called the temperature on the sticks. Relative humidity, due to its general acceptance, is a convenient measure of the moisture content of the air.

On-the-spot checks were made with that technique in West Virginia last spring during station inspection and observer training. The data are shown in table 1.

At Sharp Knob on April 21, the wide range between actual and estimated moisture content indicates that something was radically wrong. A rain of 0.03 inch had fallen the night before. Conditions naturally were changing rapidly that morning. Under such circum-

stances the surface fuel moisture and the stick moisture were not in balance with their surroundings. Relative humidity provides a poor estimate at such times, so a period when conditions have been stable for some time should be chosen for checking.

The effect of wind on fuel moisture content is complex, but indicator sticks provide a simple means of measuring it. These observations expose two of the limitations of the procedure, as well as suggest two good reasons for continuing to use indicator sticks.

Another approach may be made by determining the actual moisture content of the surface litter and comparing it with the figure in-

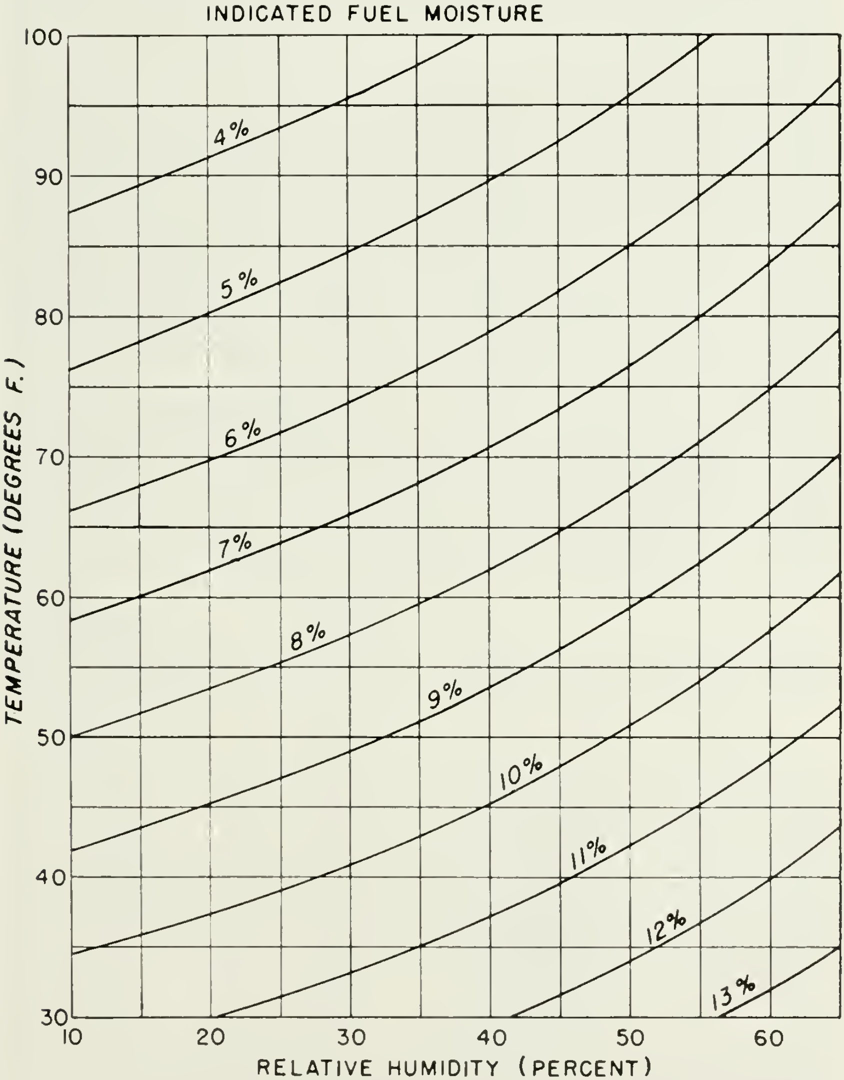


FIGURE 1.—Relation between the moisture content of slat type indicator sticks, temperature, and relative humidity under natural forest conditions during cured and transition seasons.

dicated by the sticks. This is a difficult job, particularly in pine country. Considerable care must be exercised in gathering samples to get only dead litter and only the top layer. Pine needles are inclined to intermingle with lower layers.

Surface litter samples taken on the Francis Marion National Forest in South Carolina on April 27 at 1 p. m. showed an average moisture content of 5.5 percent. Stick moistures at Bethera Tower were recorded as 7.0 percent at 12 noon and 5.5 percent at 5 p. m. Such close agreement seldom occurs, and it is possible only under very stable conditions. The sticks are intended to reflect changes in moisture content in the same degree as the litter but not necessarily the actual moisture content.

The fact that the behavior of each set of sticks almost always follows the group pattern is not merely a matter of chance. Basswood slat stock is purchased as free of defects as possible. Careful sorting upon receipt removes any other defective pieces which might not behave satisfactorily. These carefully sorted sticks are later exposed in the open until they lose 5 percent of their original weight. That step is necessary to overcome the initial period of rapid weathering. Later losses in service are small and can be offset by adjusting the dry weight of the set. Thereafter, the slats are oven-dried and grouped into sets of approximately uniform weights. Following that, the sets are tested at two prescribed temperature and relative humidity levels: whereupon all sets which show a departure of more than ±0.4 percent from the average are discarded.

Fuel moisture indicator sticks are not infallible, but the variation between sets should not exceed ±0.4 percent. The scale is accurate within ±0.25 percent at low moisture contents, and the weathering correction should offset weight losses within ±0.5 percent. Any

TABLE 1.—*Comparison of actual and estimated stick moisture content at various stations in West Virginia, Apr. 19–26, 1948*

Date	Time	Station	Relative humidity	Temperature	Wind velocity	Actual moisture content	Estimated moisture content
1948			*Percent*	°*F.*	*M.p.h.*	*Percent*	*Percent*
Apr. 19	11 a. m.	Huttonsville	19	78	0	5. 2	5. 2
Apr. 20	10 a. m.	Beaverlick	14	84	0	4. 6	4. 5
Apr. 20	3 p. m.	Neola	18	80	4	6. 3	4. 9
Apr. 21	11 a. m.	Sharp Knob	57	50	10. 5	23. 5	10. 6
Apr. 21	4 p. m.	Cranberry	60	50	4	12. 0	10. 8
Apr. 22	1 p. m.	Mikes Knob	15	77	4	5. 8	5. 1
Apr. 23	11 a. m.	Bee Mountain	15	90	(1)	4. 8	3. 9
Apr. 23	4 p. m.	Kendalia	21	75	0	5. 3	5. 6
Apr. 24	10 a. m.	Buck Knob	24	87	0	4. 5	4. 5
Apr. 24	3 p. m.	Blair Mountain	12	96	(1)	3. 6	3. 4
Apr. 26	12 m.	Mingo Mountain	11	100	5	3. 2	3. 0
Apr. 26	5 p. m.	Tick Ridge	15	90	(2)	4. 2	3. 9

[1] Varying from 0 to 2.0.
[2] Varying from 0 to 1.5.

errors in excess of those amounts are usually due to improper handling or weighing.

All in all, checks in West Virginia, New Hampshire, Virginia, and South Carolina show that if care and precision are used in fuel moisture measurements, the record of individual sets of sticks compares significantly with the group average.

A Gee Whiz on Fire Line Construction.—The Gee Whiz, a horse-drawn spring tooth cultivator, has been used by farmers in the South for many years for working new ground. A few farmers have used it as a tool for fire line construction. About 1938 the Forest Service hired Louis H. Nowland, one of these farmers, as a lookout. He repeatedly asked why the Gee Whiz was not used on fires by the Forest Service but we stuck to the conventional Council tool and ax.

In March 1947 Mr. Nowland again brought up the subject during a fire inspection. The inspectors visited a farm where the farmer had built a Gee Whiz on a Roto-tiller garden tractor. It looked good, so the ranger was authorized to purchase one for experiment. A five-tooth Gee Whiz was purchased for $11. Several trial runs were made, with the ranger's pick-up for power. The pick-up had an extra low gear so it would travel slow enough for a man to walk behind it and guide the cultivator. These trial runs built some very good fire lines.

During these trial runs we found that the device worked best with the teeth set so that they turned the debris all in one direction. Also, when being operated by an inexperienced man, about 20 pounds of extra weight should be added to the Gee Whiz (to supply this weight a large stone was placed in the fork of the handles). The Gee Whiz showed up so well in the trials that we purchased two more. One of these has been placed with a warden tool cache and the warden has signed a rental agreement to use his mule and the Gee Whiz on fire suppression.

On March 11, 1948, the lookouts reported a large fire at 5 p. m. This was our first chance to use the Gee Whiz on actual line construction. The fire was coming up a steep slope to a long narrow ridge. Pine needles were 4 to 6 inches deep on the ridge. We took the pick-up as far down the ridge as we could and fastened the Gee Whiz to the back with a short piece of chain and started out. Seven minutes later two men, a pick-up, and the Gee Whiz had built 15 chains of fire line. One other man had backfired most of the line. About 4 chains had to have the second trip made over it to completely clear the line. No line was lost. The line was about 16 inches wide and went down into mineral soil about 2 inches.

The experience gained on this fire showed quite plainly that a man cannot handle a Gee Whiz at more than 3 miles per hour for more than a very few chains, so if a pick-up is used for power, it should have a truck transmission with four forward speeds.

On March 25, State Ranger Leroy Taylor drove up to a fire of over 200 acres. He had two men with him. At a nearby farmhouse he enlisted the help of a man and a boy, and the farmer's mule and Gee Whiz. There was a large amount of black jack oak limbs on top of a heavy accumulation of oak leaves and pine needles. It was necessary to make three trips over each segment of line. The first trip cleared off the brush and part of the leaves. The second cleared the line about 16 inches wide and 2 inches into mineral soil. The third was deadheading ahead to the next segment. One man drove the mule, one guided the Gee Whiz. The third backfired the line and the remaining two held the line and patrolled it. In 2 hours they constructed 50 chains of fire line through fairly heavy going. Taylor estimates it would have taken the five men approximately 5 hours to construct a line through that same location with Council tools.

The results of our experimenting so far have proved that the Gee Whiz is a good, cheap, light fire tool if it can be gotten to a fire with some type of power to pull it that can get around in the woods. The use of a pick-up truck for power is limited to the very accessible locations. It is often hard to locate a mule or horse that is available to pull the Gee Whiz. We hope to be able to try a jeep in the near future. It should be able to go over all but the very roughest of the country and will have more than ample power to pull the cultivator.—DON L. GERRED, *District Ranger, Talladega National Forest.*

BRUSH GUARD AND TIE-ROD PROTECTOR FOR THE JEEP

Solon Hyde

District Ranger, New York State Conservation Department

In the spring of 1946, the State of New York acquired its first jeep for use in forest fire control. It was felt that there would not be much advantage in having a jeep unless it could be used for transporting water, fire-fighting equipment, or supplies over terrain too rough or too steep to be negotiated by a conventional type of vehicle. Further, it was intended that this jeep would travel not only over rough steep going in open country, but when necessary, in brush or small saplings to the limit of its capacity to push through. To do this the jeep required protection. The result was the development of the brush guard and tie-rod protector shown in the accompanying illustrations.

Figure 1 gives a good general idea of the construction of the brush guard. This brush guard is made of two pieces of 3-inch channel iron, each piece being approximately 13 feet 3 inches in length. These pieces are joined together in front, where they are secured by 4 bolts to a **U**-shaped supporting brace, which is bolted to and projects

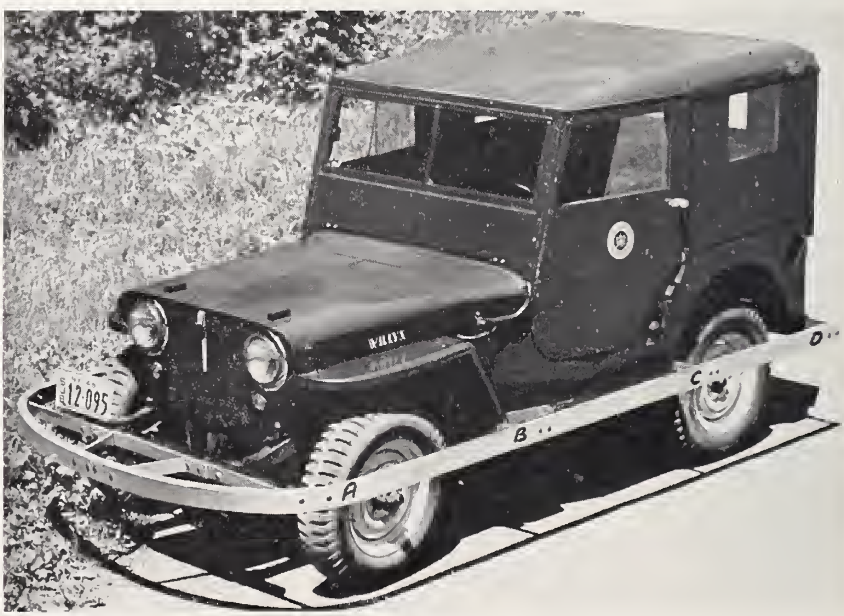


Figure 1.—Jeep of the New York State Conservation Department equipped with brush guard and tie-rod protector.

about 1 foot in front of the bumper. Other supporting braces are at points A, B, C, and D in the illustration. All braces except C are made of ½- by 2-inch iron. Brace C is made of ½- by 1½-inch iron, and goes through to the other side. It lies flat on the frame of the vehicle, is bolted to the top of the frame on each side, and then is twisted and shaped at each end to be bolted to the channel iron guard. Braces at points B and D do not extend through. Brace B is bent back and bolted to the side of the frame. Brace D is bolted straight to the rear of the frame.

Figure 2 shows the construction of the tie-rod protector from below. This consists of an iron plate 16 by 20 by ⅛ inches, reinforced by 3 heavier iron braces. The 2 outer braces are ½- by 1½-inch iron, the middle brace ⅜- by 2½-inch iron. The front of this assembly is bolted to the bottom of the jeep bumper, and the rear

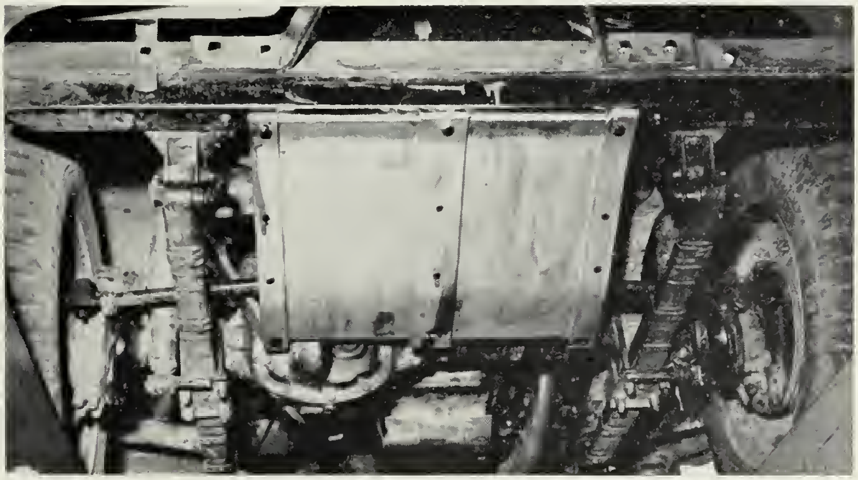


FIGURE 2.—Tie-rod protector from below.

to the supporting brace which bends upward on each end to be bolted to the frame of the car. This rear support is made of ½- by 1½-inch iron.

It will be noted that no dimensions other than sizes of iron used in construction have been given. The only important dimension is the complete over-all outside width of the brush guard. While it is desirable that this be as narrow as possible, it must be wide enough to permit maximum turning of the front wheels, and also to permit the removal of a wheel to change a tire. It was found that 70 inches over-all width, with 3-inch channel iron for the guard, was about the minimum. This width is about 2 inches wider than necessary to permit the full cramping of the wheels, but it is necessary for the use of tire chains on the front wheels and to permit the removal of any wheel. However, using an over-all dimension of 70 inches does not permit the removal of a wheel unless the vehicle is jacked up with a bumper jack applied to the brush guard, thus letting the wheel sag sufficiently so that it may be readily removed. The necessary clearance between the inside of the brush guard and the front tire is 6 inches.

No cost data are available on the construction of these protective features. The need for the devices was recognized. One of the rangers, who is also a good blacksmith, was assigned to the job, and with the help of a couple of other rangers produced the results on our first jeep in a matter of 3 days. The material used on the first one was on hand. No drawings other than rough sketches were made and there were no calculations regarding stress and strain. The idea was "Be sure it is strong enough." No holes that might weaken the frame had to be drilled. In most cases it was possible to attach supporting braces to existing holes in the frame.

The first jeep so modified was subjected to rigid tests, and the protective guards stood up. Three more jeeps have been equipped in the same manner. The vehicle illustrated recently delivered water on a fire where one would think that only a crawler type tractor could go without suffering major damage. Lacking these protective devices, the jeep would never have been considered by the ranger for driving to the site of this fire.

Equipment Service in the Region 5 Emergency Fire Plan.—In Region 5 the servicing of equipment is conducted on a centralized basis. The Region is broken down into three areas. Each area has a central equipment depot and repair shop, with a branch shop on most forests. A superintendent has charge of equipment assignments in the area as well as the general overseeing of repair shops.

In addition to carrying on the various duties incident to equipment repair, the Equipment Service is geared to the emergency fire organization through the fire zone dispatcher who requests services when a forest is unable to handle the job with personnel and equipment already assigned.

In general, depot overhead, mechanics, truck drivers, and such clerical help as may fit into the fire organization are split into two teams. One team is on call 24 hours per day for 7 days, at the end of which period the second crew takes over on an uncalled basis. This gives a crew of overhead with a properly selected working crew to start required action upon call from the zone dispatcher.

In addition to the stand-by personnel, certain equipment is kept on hand at the central equipment depot. A typical roster of stand-by equipment would be as follows: 2 transport trucks, 2 D–7 tractor trailbuilders, 1 convoy luber, 1 fuel truck, and 4 stakesides.

In the stand-by crew are usually a tractor mechanic and a pumper mechanic who are available to accompany equipment to a fire. The on-call crew mans the transport truck, convoy luber, and fuel truck. The stakeside trucks and tractors are usually manned by zone personnel.

The off-call crew will, in most cases, be available immediately on call or within 1 to 3 hours after they are contacted unless permission has been granted to be out of contact for a longer period.

In the forest branch shops, the shop foreman cooperates with the forest fire control officer or dispatcher in setting up the fire organization. On large fires, the forest shop foreman is usually instructed to report to the fire camp to take over equipment repair and servicing for the transportation officer. Mechanics and helpers furnished from either the depot or other sources are usually placed under his jurisdiction.

In the foregoing capacity, the Equipment Service personnel relieve the zone dispatcher of a considerable amount of work incident to placing equipment on large fires; also they act to obtain equipment from other areas and to provide rental equipment from outside sources in case the need of the area in question exceeds the equipment available. It is evident that the area superintendent must not only know sources of Forest Service equipment but also keep his fingers on possibilities of commercial rental equipment.—Verl Jeffrey, *Acting Equipment Engineer, Region 5, U. S. Forest Service.*

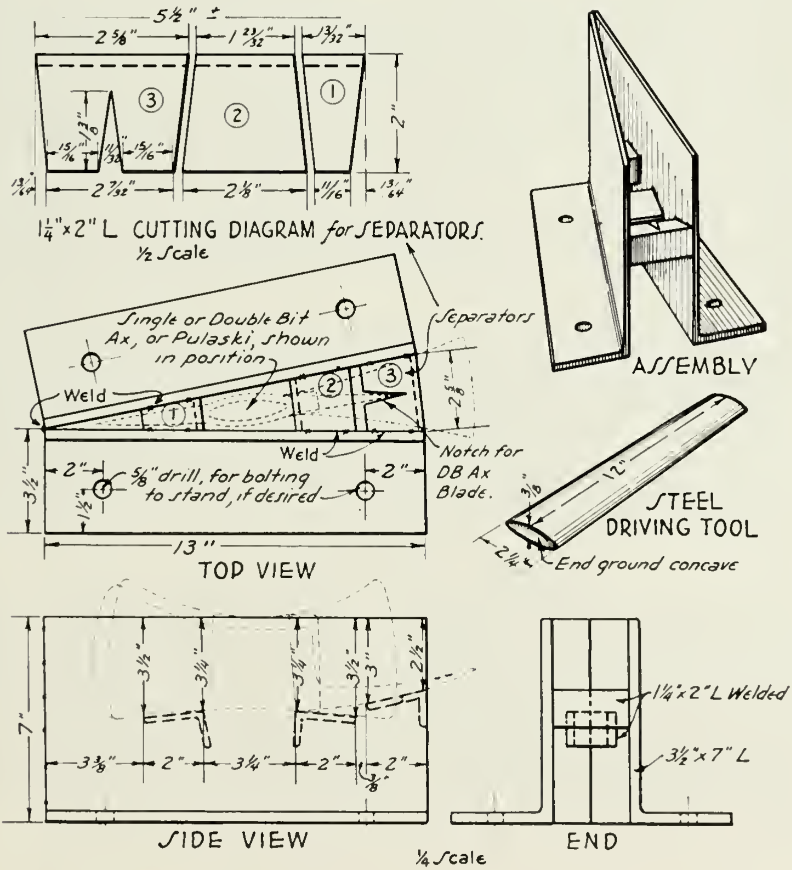
BROKEN HANDLE REMOVER FOR SINGLE AND DOUBLE BIT AX AND PULASKI

Division of Fire Control
Region 4, U. S. Forest Service

A safe and fast method for removing broken ax and Pulaski handles from the tool heads has been developed by John Nasi and Tom Coski of the Payette National Forest and F. E. Powers of the Salmon National Forest. The idea originated in Region 1.

The broken handle remover consists of a holder, in which a head from either a double or single bit ax or Pulaski may be placed, and a steel driving tool. To remove the broken handle saw off the handle flush with the ax head, then place head in holder and drive out the wood in the eye with the driving tool. Holes may be bored in the end of the eye wood to aid in removing stubborn wedges.

The remover can be made of hardwood bolted together; inside dimensions should be the same.



EXPERIMENTAL TRIAL OF WETTING AGENTS

Division of Fire Control

Region 9, U. S. Forest Service

About a year ago five forests in Region 9 were furnished with small supplies of a wetting agent for experimental purposes. While only three of the forests have reported, and one of these has only tested the material on a brush pile fire, all were quite enthusiastic over the results obtained and the possibilities of a wetting agent for effective fire suppression. Excerpts are quoted from their reports.

Mark Twain National Forest, Mo.

"Solutions were used in back-pack pumps by fire fighters on approximately 20 fires during the recent fire season. Their observations are as follows: Both 1-percent and 2-percent solutions were more effective than water in all types of fuel.

"These solutions were found to be especially valuable in knocking down hot spots, extinguishing spot fires, and in checking spread until the line could be constructed. The solution seemed to go farther and to hold a fire in check much longer than water did. These were particularly important features on high danger days with strong shifting winds. The solutions had greater penetration than water, which made them very effective in deep leaf litter, our most common fuel. Probably because of its penetrating quality, the wet water will extinguish faster and hold a fire in check longer than plain water. This was noticeable in the heavier fuels such as oak slash and snags. In line construction, line holding, and in mop-up, the solutions were very definitely superior to water.

"The 2-percent solution seemed much more effective than the 1-percent solution. It is estimated that it compares in effectiveness with the 1-percent solution as the latter compares with water.

"Although several of the back-pack pumps held the solutions for weeks, there was no apparent corrosion of the galvanized lining. This, however, may not have been a sufficient test of the corrosive properties of the solution. If corrosion will not occur or can be prevented, it would be very desirable to use the 2-percent solution in the pumper units."

CHIPPEWA NATIONAL FOREST, MINN.

"It so happened that we did not have an opportunity to use the solution on an actual fire. However, one of our Rangers experimented with it in extinguishing a brush pile fire on a road clearing job this fall. The brush pile was burning well and one application of the solution resulted in complete extinguishing of the fire. It appeared to do a very good job of saturation.

"This forest also experimented with the use of other wetting agents. These were also found to be satisfactory, but were more difficult to mix."

LOWER MICHIGAN NATIONAL FOREST, MICH.

"The Mio District had an opportunity to give wet water a good trial on the McNeely, Class C, fire which occurred on Sunday August 17.

"This fire started in the middle of a large area of jack pine slash produced a year ago. The fire danger at 9 a. m. was 21, at 1 p. m. the danger was 39. The fire started at about 11:30 and was reached shortly after noon. The greater part of the suppression work took place near 1 p. m. so it would be safe to say the fire danger during the suppression period was 39. There was an 11-mile wind at about 1 p. m. and at times there seemed to be gusts of wind of higher velocity at the fire. It had been 15 days since a rainfall of 0.01 inch had occurred. The humidity at 1 p. m. was 48 and at 5 p. m. was 46. The fire was held to 23 acres, of which practically all was slash covered. Individual trees were observed to crown, but the crown fire never carried from tree to tree. The area had been cut over and there was only a light stand left which probably helped prevent the crown spreading.

"The fire spread across full width furrows and we were unable to stop it with only water in the back-pack pumps. After the fire would be knocked down it would seem to dry out and start up again. I then brought in our pumper and put the 10 gallons of wet water in the 200-gallon tank, a rate of 1 gallon of wet water to 20 gallons of plain water. We used the pumper and hose on some piles of burning slash and on burning snags and stumps with very satisfactory results. We filled the back-pack pumps with the wet water mixture and found that when the spreading ground fires were extinguished with the wet water they stayed extinguished. By the time we got the wet water into action a large number of volunteer fire fighters had been recruited or had reported without request so we had sufficient men to handle the available back packs with the wet water and we soon had the fire under complete control.

"Considering the fuel conditions, the burning index, and the comparison with the plain water we were all convinced that the use of the wet water was well worth while and that we should secure additional supplies for future use and test. If we find that the wet water is not any more corrosive than plain water, I would advocate having all of our first run equipment supplied with it at all times."

HUSKI GARDENER FIRE PLOW

R. F. Irwin

District Ranger, Trinity District, Davy Crockett National Forest

The Huski Gardener is a two-wheeled garden-type tractor with a Briggs-Stratton gasoline engine for power. It was first used in Texas by the Texas Forest Service, who developed the plow attachment with 12-inch rolling coulter and front brush guard. Two of these plows were secured by the U. S. Forest Service for experimental use in Texas, in October of 1947.

The following items have been added to the original Texas Forest Service plow: Brush guard over handle bars to protect operator; prestone solution in tires to increase weight; 6-volt battery and headlight for night work; 4-quart canteen in a rack; backfire drip torch; 4-pound double-bitted ax; fire rake; tool box containing Allen wrench, first-aid kit, snake-bite kit, pocket compass, map, notebook, pencil, and 4-cell electric head lamp. Cost of the Huski plow tractor was $300; the plow, coulter, and brush guard, $150; and the battery, headlight, and tool brackets, $25.

The Huski plow is 29 inches wide and will fit into a 48-inch pick-up bed, allowing a 17-inch tool box to be mounted on one side of the bed (fig. 1). The Huski plow unit consists of a pick-up truck loaded as

Figure 1.—Huski plow unit loaded on pick-up truck.

follows: The usual tool box carrying 4 fire rakes, 1 shovel, 1 double-bitted ax, 1 4-quart canteen, 1 portable phone; a back-pump crate which contains two 5-gallon back-pack pumps and two kerosene lanterns; a 55-gallon drum of water with rotary pump for filling back cans; a sled for carrying the water drum, and the Huski plow. This load weighs about 900 pounds.

A significant value of this unit is that two or three men making a quick getaway to a fire can strike with the working equivalent of seven to ten men far sooner than such a force of hand-tool men can be gathered and transported to a fire (table 1).

Some advantages of the Huski plow unit are as follows: Plow is light and flexible. It can be transported any place a pick-up can go. The plow can be walked across country at a rate of 1½ miles per hour, and it will plow a line 18 inches wide at a rate of 40 to 80 chains per hour in shortleaf-loblolly pine type with moderately dense underbrush. The motor is so geared that the wheels keep turning when the plow is "hung," and the motor is seldom choked from overloading. The plow will replace 5 to 8 men using fire rakes, depending upon conditions.

By means of a "wooddeck" loading ramp, the plow can be loaded from the storage shed in less than 5 minutes. This eliminates the need for a stand-by pick-up truck. Cost of operation is almost negligible since one gallon of gasoline will operate the plow for 2 to 3 hours, and the motor requires only 1 half-pint of oil every 25 hours of operation.

TABLE 1.—*Summary of the use of Huski plow on seven fires in flat country*

Fire class	Soil type condition	Ground cover	Number of men in crew	Chains of line per hour	Remarks
B	Dry, sandy	Sl-loblolly pine, medium underbrush.	5	96	Good line.
C	Very dry clay and some sandy loam.	Open pine, heavy grass.	5	30	Only fair line: dry clay soil difficult to plow. Gullies present.
C	Very dry, sandy	Sl-loblolly pine, dense underbrush.	2	30	Night, only fair line.
B	do	Sl-loblolly pine, light underbrush.	2	80	Very good line, held 30 chains in ½ hour with 2 men.
B	Damp bottomland.	Bottom-land hardwood, no underbrush.	2	88	Night, good line
B	Moist, sandy	Sl-loblolly pine, medium underbrush.	3	60	Good line.
B	do	do	2	50	Fair line, had to stop plow to backfire.

Some disadvantages of the plow unit are as follows: Plow must be operated by a man walking. In heavy underbrush this is strenuous work and wears out the operator very quickly. The tractor has a very delicate clutching system and has no reversing gear to back it up when the plow hangs. After installation of 6-volt battery and headlight, plow became somewhat top-heavy. An unskilled operator will have occasional upsets.

It has been determined by actual use that a skilled operator using the Huski fire plow, can build a good 18-inch fire line at the rate of 40 to 80 chains per hour in shortleaf-loblolly pine type, with moderate underbrush. The operator should be assisted by an axman in the lead to clear out logs, and a man with a fire rake behind the plow to clean out skips and "roll backs." There should be a fourth man for backfire, although, on the small fires either the rakeman or the axman can drop back to handle the backfire.

In conclusion, it is believed that the Huski plow is well worth the cost. Correction of clutch difficulties and training of two skilled operators to go with the plow to each fire should make it a very successful piece of fire control equipment. The plow is suitable, principally, for operation in light sandy soils of the shortleaf-loblolly pine type with moderately dense underbrush.

Use of SX Radio in Aircraft.—To obtain air to ground radio communication on the Los Padres National Forest by the use of regular U. S. Forest Service radio equipment the SX type portable two-way radio has been found to work satisfactorily. This equipment has been used during approximately 900 hours of flying on the forest with better than 95 percent of plane to ground calls completed. Calls averaged four per hour of flying. The equipment naturally does not compare with that designed for aircraft, but is practical, especially in the infrequently used contract ship.

Several types of antenna set-ups are possible. In most aircraft the regular antenna wire may be attached to either the tail or wing assembly and strung through the window of the plane directly to the radio. On some types (Beechcraft Bonanza) it may be necessary to attach a permanent L-shaped clip to the wing tip in order to have something to which to tie the antenna. Wire should be fairly taut to avoid whipping.

On the Stinson "Voyager" the standard aircraft antenna may be utilized by soldering a 6-inch piece of extension aerial to it and extending this wire through the zippered inspection slot above the pilot's head. A convenient length of wire then connects this to the radio. No adjustment of the radio has been found to be necessary to accommodate it to the plane antenna. The aircraft radio must be turned off before SX aerial is clipped on or the tubes of the SX will be blown out.

The radio is operated in any convenient location in the ship. Ear rubbers on the headset are required to exclude plane engine noise.

With some practice by the operator and cooperation from the pilot it is felt that no aerial observer should be without radio communication when any regular Forest Service crystal controlled portable radio set is available.

It must be taken into consideration that the SX radio was not primarily built for use as an aircraft receiver and hence is not as efficient as a commercial receiver, however until we can get a better piece of equipment the SX will be the only radio in use on the Los Padres aerial project this season.
WARREN E. BARNES, *Fire Control Officer, Los Padres National Forest.*

Meeting A Fire Situation.—The fire boss has to consider many factors, analyze and correlate them, and make his decisions in order to be assured of a successful plan to control a fire. The failure to take into account any one of the factors can easily mean the difference between catching the fire promptly and losing it. The need for prompt but sound decisions is all important due to the rapidity with which fires can spread and cause damage. The fact that a forest fire presents an emergency situation often results in the fire boss or his staff overlooking some of the factors.

The following outline or check list was worked out at the advanced Regional Fire Strategy and Organization School to aid the trainees in making a complete and systematic plan for control of the fires presented in the course's big fire problems. It is the joint product of the instructors and fire men who attended the training sessions. The outline resulted in better planning and it was agreed generally that the fire boss and his staff could make good use of such an outline when actually on a fire.

P PROBLEM
- a. Fire facts (inventory)
  - 1. Behavior of fire:
    - (past)
    - (present) Time of day and year
    - (predicted)
  - 2. Weather
    - Wind:
      - (velocity)
      - (direction)
      - Times
    - Humidity
    - Fuel moisture
  - 3. Topography
    - Features—ridge, saddle, river, etc.
    - Slope
    - Barriers
    - Culture—roads, trails, firebreaks, etc.
  - 4. Cover
    - Type
    - Density
    - Continuity or changes
    - Values
    - Control accomplishments
- b. Facilities for fighting the fire (inventory)
  - 1. Manpower, overhead, equipment, tools
    - Kind
    - Quality
    - Quantity
  - 2. Production rate
  - 3. When available

A ANALYSIS OF SITUATION
- Consider, correlate, and calculate elements applicable to the fire

P PLAN
- a. Line
  - 1. Strategy and broad tactics by individual sectors
  - 2. Alternate plans of control and conditions requiring their use
  - 3. Time action is to be completed—priority, sequence
  - 4. Assignment of overhead, manpower, tools, special equipment by sectors
  - 5. Reserve forces available
- b. Plans
  - 1. Information to be gathered and time required
  - 2. Records to maintain
  - 3. Assignment of personnel and facilities
- c. Service
  - 1. Services to be provided—quantity, location, and time
  - 2. Assignment of personnel and facilities

E EXECUTION
- a. Convert plan into action
  - 1. Brief personnel
  - 2. Dispatch personnel
  - 3. Provide follow-up supervision

R REVIEW AND REMEDY
- a. Check—each step from inventory to execution
- b. Inspect performance and accomplishments
- c. Modify plan promptly to meet changed conditions, errors, or omissions

One feature of the outline is that it has a catch word "PAPER" to make it easier to remember the main steps and their sequence in meeting a fire situation; P for problem, A for analysis, P for plan, E for execution and R for review and remedy. This is a patterned after a similar device used in many Air Corps check lists.—George M. Gowen, *Forester, Region 5, U. S. Forest Service.*

PROBLEMS OF FIRE PROTECTION ON REFORESTED STRIP-MINED AREAS IN INDIANA

S. J. Hensler and J. H. Winchell
District Foresters, Indiana Division of Forestry

Foresters in Indiana are viewing with some concern the problems in fire protection on some 14,000 acres of stripped coal lands that have been or are being reforested. The Strip Mine Act of 1941 requires that strip coal mine operators revegetate all land stripped (fig. 1) since the enactment of the law. At the present rate of stripping more that 2,500 acres will be planted annually with trees (fig. 2). The chief difficulty is in the uncertainty of just how severe or mild the fire protection problems will become as the trees get older and complete timber cover is accomplished. At the present time the problem of fire protection in these lands is not significant of anything that might happen in the future. There are no cases on record where a fire has swept over spoil lands to destroy a natural cover or a plantation of young trees. Fuel conditions conducive to burning are in general lacking on most stripped areas. Even the older plantations 15 to 20 years in age do not have as yet an accumulation of duff which might be considered a severe hazard. Just what will happen when these plantations, which are principally pine, advance in age and leaf litter and dead branches accumulate remains to be seen.

Figure 1.—Stripped area before planting. Note the long, narrow lake.

FIGURE 2.—A typical young pine planting on a strip-mined area.

The stripped lands from a fire protection standpoint have several factors in their favor. Most areas have long narrow lakes sometimes a mile or more in length which will act as natural fire barriers. Deep box cuts in many cases separate the stripped areas from adjacent flat lands and will act as fire barriers. Old haulage roads will act as barriers also and provide, to some extent, access to the areas. Another factor which from the surface is not readily apparent but has been definitely established is that soil moisture conditions are higher in the strip bank than on adjacent unstripped areas. This might indicate that fuel moisture conditions will also be high.

On the other hand there are several factors which can add to the difficulties of fire protection.

As already mentioned the reforestation of stripped lands has been largely with pine species. These of course constitute a more severe fire hazard than hardwood species. Most areas will offer little encouragement toward the use of any mechanized fire equipment as the terrain in most cases is forbidding. Unless access roads or fire lines are constructed the fire fighting will be limited to the use of hand tools.

The area of the stripped lands does not come under the surveillance of the present tower detection system and this along with access roads and fire lines will have to be planned.

Present trends point toward heavy use of stripped lands for recreational purposes. Many lakes on these lands are already intensively used for fishing and boating. Many areas offer attractive sites for cabins and will no doubt be more fully developed for this purpose in the future.

With a heavy influx of recreationists during periods of high fire danger the problems of fire protection will no doubt increase.

The State Division of Forestry feels that any problems in fire protection which are peculiar to these areas will be solved with the excellent cooperation of the coal operators.

VEGETATION TEMPERATURE AND FIRE DAMAGE IN THE SOUTHERN PINES

George M. Byram

Physicist, Fire Research, Southeastern Forest Experiment Station

It has long been known that pine stands in the South are more severely damaged by late spring or summer fires than by winter fires. The usual explanation is that a stand is most susceptible to fire injury during the growing season, or that dormant trees during the winter season are least susceptible. It is also thought that summer fires are hotter than winter fires.

Summer fires probably do have a somewhat higher intensity than winter fires. It is also likely that pines may be slightly more susceptible to injury during certain periods of the growing season. However, a theoretical analysis of the factors contributing to fire damage has shown that other factors may be considerably more important than the two just mentioned. The details of the analysis are outside the scope of this discussion, which will concern the results of the analysis rather than the technical aspects of its development.

The lethal temperature for plant tissue is in the neighborhood of 140° F. It may be assumed that the buds, needles, and branch endings of a pine will die if heated to a temperature exceeding 140°. An analysis of the lethal effects of fire, therefore, reduces to an analysis of those factors which directly or indirectly affect the temperature of the susceptible parts of a tree. Of these, the initial vegetation temperature may be one of the most important. The temperature of the foliage of a pine in bright sunlight may exceed 105°. Therefore, an increase of only 35° would be required to reach the lethal temperature, and the absorption of a relatively small amount of heat by the foliage would accomplish this. On the other hand, the foliage temperature might be only 35° or 40° during a cold period in winter. Under these conditions considerable heat would be required to raise the temperature up to the lethal value of 140°. A fairly intense fire during cold winter weather might therefore do no more damage than a low intensity fire in hot summer weather. The same comparison might be made between hot and cold spells both occurring in the winter, or both occurring in the spring.

Theoretical curves in figure 1 show the relative fire intensities that longleaf, slash, and loblolly pine should tolerate at different temperatures. At a temperature just above freezing, any one of these pines should tolerate a fire more than twice as intense as it would on a warm day when the vegetation temperature is 95°. One of the most noticeable features about the curves is the sudden increase in a pine's heat tolerance at temperatures below 29°. At this temperature, since most of the water in the needles and buds would be frozen, large quantities

of heat would be required to convert the ice back to water. At a temperature of 29° pine foliage should tolerate a fire about four times as intense as at a temperature of 95°. Some field men have noticed that cold weather fires have resulted in much less damage than might be expected.

Curves for hardwoods should be very similar to those for pine, except that their heat tolerance would be lower. In stands managed for the perpetuation of pine, hardwood sprouts could probably be girdled most effectively by burning in hot, sunny weather.

Another important factor associated with temperature changes in the crown of a tree concern the morphological characteristics or "geometry" of the needles, buds, and branch endings. The rate of temperature rise in these susceptible parts is inversely proportional to their size. When they are massive and heavy, they will not reach as high a temperature as when they are thin and light. This may explain why suppressed trees, the susceptible parts of which are dwarfed and of small volume, are more easily killed by fire than vigorous trees of the same size. It may also explain why longleaf pine is less susceptible to fire than other species of pine. Also the terminal buds of long-

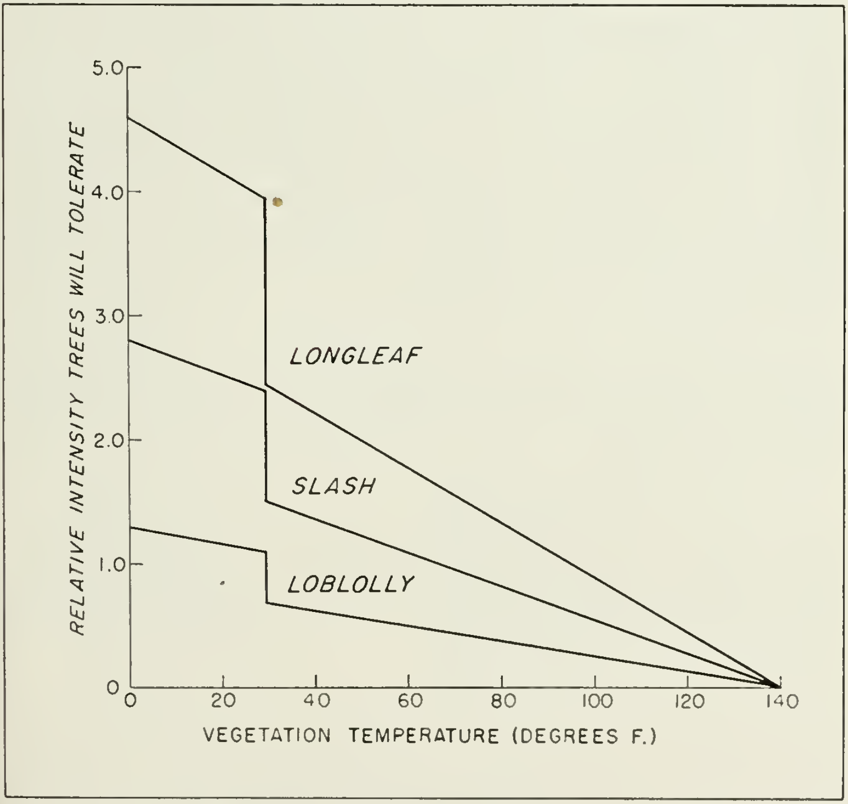


FIGURE 1.—The theoretical relation between vegetation temperature and a tree's heat tolerance. Heights of these curves represent the relative fire intensity that slash, longleaf, and loblolly pine will tolerate at different vegetation temperatures. The three species of trees are assumed to be of the same size

leaf are surrounded by a protecting sheaf of needles which retards a temperature rise in the bud.

The following tabulation shows the diameter in centimeters of the terminal buds on longleaf, slash, and loblolly pine. Susceptibility ratings are given in the third column. These ratings are found by taking the reciprocals of the values in the bud-diameter column.

Species:	*Bud diameter*	*Fire Susceptibility*
Longleaf pine	1.16	0.86
Slash pine	.72	1.39
Loblolly pine	.33	3.00

The relative positions of the three curves in figure 1 were determined by the diameters of the terminal buds in the three species.

Wind is another important factor affecting the temperature of vegetation exposed to radiant heat. Wind has a conductive cooling action on buds and needles, which reduces the rate of temperature rise. Men who have done much work with prescribed burning usually consider wind the most important factor in the amount of scorch they are likely to get. Unlike temperature, many of the effects of wind can be readily observed. A sudden shift in the wind can convert a low intensity backfire into a high intensity headfire in a few minutes' time.

Some of the effects of wind are not yet well understood. It is known that scorching is severe when a fire burns in calm air. In this case, lack of turbulence permits the hot gases to pass straight upward in a more or less streamline flow. However, recent thermocouple measurements indicate that there may be additional reasons for the scorching in calm air. When a line of fire passes under a tree, the foliage is subjected to two peaks of intensity. One peak is the result of radiant energy from the approaching fireline; the other is caused by convective heat from the burning gases. For a backfire the peak for radiant heat comes first, and for a headfire the peaks occur in reverse order. In calm air they occur simultaneously.

It is difficult to compare the relative importance of wind and temperature because their effects are interrelated. In a headfire, wind increases the fire intensity by speeding up the combustion process. This is partially offset by turbulence which retards the upward flow of heat. In addition, wind exerts a conductive cooling effect on buds and needles.

Basic studies are now in progress on the Francis Marion National Forest to obtain experimental checks on the results of the theoretical work discussed in this paper. In addition, these studies should yield information for determining the proper place of fire in the management and protection of loblolly pine. This information should also be applicable in large part to other species of pine such as slash, longleaf, and possibly even shortleaf.

Higher Helicopters Limits.—The value of the helicopter in fire suppression activities is no longer questioned. Anyone who read Frank Jefferson's excellent article on the subject in the January 1948 issue of Fire Control Notes should need no further convincing that rotary-wing aircraft has long since passed the experimental stage in this field. But helicopter operations have always been hampered by the low hovering ceiling of the aircraft. Forest Service reports in 1945 stated that a helicopter then being tested (Sikorsky R–5A) lacked the ability to carry the necessary pay load in spot landings and take-offs at elevations over 3,000 feet with summer temperatures. Two years later, California foresters used improved models at elevations up to 5,400 feet under similar conditions. But this is still not sufficiently high in the Rocky Mountain Region, where in most places an elevation of 5,400 above sea level only means an impressively deep hole in the ground.

It was, therefore, with considerable consternation that we learned that the Denver branch of the U. S. Geological Survey had chartered a helicopter to transport surveyors in triangulation work on a mapping job near Canon City, Colo., last winter. It was intended that the machine should transport surveyors and their equipment, one at a time, from the airport to adjacent triangulation points. Since the elevation of the Canon City airport is a prohibitive 5,500 feet, the project seemed a shade on the doubtful side; but the Geological Survey report, portions of which are given below, speaks for itself:

"The helicopter operation was accomplished in 10 man-days. The same triangulation work, under summer conditions and by automobile and foot travel would have taken an estimated 36 man-days.

"Wind velocity for these operations varied from zero to an estimated 40 m. p. h. One take-off was accomplished from 9,300 feet above sea level with a 12 m. p. h. wind; and one at 10,200 feet in zero wind. The temperature varied from 4° to 48° F., with most flights being made while the temperature was above 32°. All high altitude landings and take-offs were made under favorable conditions, but it was eventually decided to forego any more landings at extreme elevations due to the fact that the weather and wind conditions were not sufficiently stable at this time of the year to provide the necessary margin of safety required at maximum altitudes.

"During the second day of the operation, Mark Rousseau was transported to a mountain peak at an elevation of considerably over 10,000 feet above sea level. He erected a triangulation signal and was returned to the airport by the helicopter; but after discussions with the pilot, it was decided not to attempt to occupy this point as he stated that every bit of power was required to make the take-off from this point and it would be unsafe to make repeated flights to points of that elevation.

"All triangulation point landings were normal hovering landings. All take-offs were normal hovering or 'jump' take-offs."

There is no doubt but that unusually favorable temperature and air density conditions enabled successful helicopter operations at such elevations and that the aircraft was being skillfully piloted near its uppermost limits, but the machine itself deserves considerable credit. It was a Bell 47D, currently the latest thing in commercial helicopters. Some of its specifications follow:

Seating capacity	1 passenger and 1 pilot
Engine	Franklin, 178 h. p.
Cruising speed	92 m. p. h.
Speed range	0 to 100 m. p. h.
Gas capacity	33 gal.
Gas consumption	12 gal. per hr.
Rotor blades	Matched woods with stainless steel leading edge and steel core
Main rotor diameter	35 ft.
Blade tip speed	400 m. p. h.

This account is not a plea for pushing our existing rotary-wing aircraft beyond their safe operating limits, but is rather an indication that further equipment development may before many more fire seasons make timber-line helicopter operations a normal procedure. Distinct hope for this is held out in a final quote from the Geological Survey report:

"Representatives from the Bell Aircraft Corporation have advised us that they have a machine now undergoing tests that will have a service ceiling of 20,000 feet above sea level, and that should be able to make hovering landings and take-offs anywhere in the Rocky Mountain area."—Wilfred S. Davis, *Forester, Region 2, U. S. Forest Service.*

SMOKE JUMPING IN THE SOUTHWEST

F. L. Jackson
District Ranger, Gila National Forest

The year 1947 started a new era of fire fighting methods in the forests of the Southwest. This was the first year the aircraft and smoke jumpers were used to suppress forest fires.

The crew of men selected and assigned to Region 3 for a trial run (fig. 1), arrived on the scene on May 23. A day or two of preparation ensued, and was followed by an actual fire call a few days later. This was the initial fire for the smoke jumpers in Region 3.

Since that time it has been demonstrated that the use of smoke jumpers is practical to reduce burned acreage in the forests of Region 3. Adaptations will have to be worked out for each forest, based on the experience gained on other forests. The 1948 project now in progress is already developing many changes and should be continued if smoke-jumper activity is expanded to other forests in the Region.

Under the present set-up on the Gila Forest, a single engine Noorduyn (C–64) is used. This ship was modified for jumper use and for dropping cargo before it came to the Region. One pilot is assigned to fly it, and to care for all maintenance as required. So far this type of plane has been found to be well adapted to conditions here in the Southwest and has given excellent service. The plane and pilot were assigned from Region 6.

Under normal operating conditions, the plane carries the pilot, a spotter (or cargo dropper), two to four jumpers, and their fire packs. The jumpers, foreman, and leader were trained and assigned from Region 1. All are well qualified to handle the suppression job.

The load the plane can carry depends upon the weather conditions and time of day. This factor is carefully weighed against the urgency of the call for the jumpers or cargo. The safety factor is given full consideration. For example, under favorable conditions the plane would carry a safe load of two thousand pounds, when later in the day during the summer months, as the temperature increases, this loading capacity is reduced to around one thousand pounds. In addition, considerable air turbulence is encountered in flight to the forest area, and unpredictable downdrafts make close flying hazardous over mountain areas. The pilot is required to fly at a low altitude over the fire or drop spot to safely release the men or cargo.

Fire detection on the Gila Forest is handled by the regular detection force on the ground. No patrol work is done, except on request while the plane is in flight. Radio contact is maintained between the plane and the ground by means of the regular plane radio and an SPF set on one of the main lookouts. Secondary contacts are maintained with SPF sets at ranger stations en route. So far this arrangement is satisfactory but it is believed could be improved upon by better location of the SPF sets.

When a fire call is received by the smoke-jumper dispatcher the crew and pilot function as one operating unit. The spotter assigned to the jump crew for the day acts as leader. The dispatcher and the

FIGURE 1.—Smoke jumpers, pilot, and plane assigned to Region 3.

pilot plot the best course to the fire from the readings given and pin point the fire location on the maps to be used by the pilot, spotter, and jumpers. A copy of the fire call request is carried by the pilot and the jumpers in the event further information is needed after they leave the ground. The spotter organizes his crew according to the request. The men are suited up on the ground, parachutes checked, numbers recorded, etc., and the pilot and spotter briefed by the dispatcher before take-off. Jumpers are instructed as to the best way out from the fire and when and where relief by ground crews can be expected. Usually the jumpers reach the fires before the ground crews though both receive their fire calls at the same time. Here is an element of competition that cannot be overlooked, especially if suppression by air crews can reach fires before ground crews, keep the fires small, and reduce the total cost of suppression and damage. On the remote areas of the Gila Wilderness Area fire suppression from the air has proved its worth judging from the records of the past 2 years.

The usual get-away time for the plane and crew is less than 10 minutes. This requires needed preparation, servicing of the plane, and a coordination of all hands toward the one important objective, getting on the fire as soon as possible. Usually fire packs consisting of chuck, beds, tools, water, etc. are prepared for two men and packaged so that it can be sent down with one chute. The minimum number of men on one jump is two men, unless fire conditions warrant more, or other emergency exists.

So far in 1948 the crew has made 33 jumps. Four fires were handled without follow-up assistance from ground men. Food and supplies were dropped to a Coronado fire of 2,500 acres, to eliminate a difficult pack string job. Some of these fires would, no doubt, have attained large proportions had they not been reached in time, and would have cost a large amount to control.

A NEW FIRE DANGER METER CARD

James R. Crowell
Dispatcher, Talladega National Forest

A simple method of using index numbers to determine fire danger on the Appalachian 100 Point Scale has been developed at the Talladega Ranger Station, Talladega, Alabama, by the writer. There are no wheels to turn, no slide rules, in fact no moving parts whatever, to wear out or to confuse the inexperienced. For example from the card illustrated below:

	Index No.
Days since ½″ rain, cured stage: 4 and over	4
Wind rate: 7.5 to 12.5 m. p. h	2
Fuel moisture: 4.0 to 12.5	4
Total	10

Now, under Fire Danger Class, index number 10 gives High IV (class day) and 45–55 (100 point reading).

FIRE DANGER METER (*Type 7*)

Days since one-half inch rain by fuel stages

Green		Transition		Cured	
Days	Index No.	Days	Index No.	Days	Index No.
0–3	0	0–3	2	0–3	3
4–8	1	4–8	3	4 and over	4
9–15	2	9 and over	4		
16 and over	3				

WIND

Miles p. h.	Index No.
0–3.4	0
3.5–7.4	1
7.5–12.5	2
12.6–18.5	3
18.6–24.5	4
24.6 and over	5

FUEL MOISTURE

Weight	Index No.
25.1 and over	0
12.6–25.0	2
4.0–12.5	4
3.9 and less	5

FIRE DANGER CLASS

Index No.	Class day	100 point reading
1–4	I	0–10
5	Low II	11–15
6	High II	16–20
7	Low III	21–26
8	High III	27–33
9	Low IV	34–44
10	High IV	45–55
11 and 12	Low V	56–77
13 and 14	High V	78–100

To determine Fire Danger use sum of index numbers in Fuel Stage, Wind and Fuel Moisture columns as index number in Fire Danger Class column.

Mobile Telephone Service in Cooperative Forest Fire Area.—It is a well-known fact that cooperation is the key to effective fire protection for certain western watersheds. In these areas the protective organization is often one knit from the suppression forces of a number of cooperators, private as well as public. Such organizations lean heavily on a reliable interagency communication system.

Recently there has been introduced into the communication picture a vehicle radio-telephone service developed by the Bell Telephone System. Subsidiaries of the American Telephone and Telegraph Company are installing such units in the heavier subscriber areas to furnish service to municipal power, water, policing, and fire protection organizations as well as private businesses having need for communication from mobile units to their central place of business. This vehicle radio-telephone system bids well to become an important adjunct to a cooperative fire protection force which is activated through a central dispatcher such as the joint Federal, private, and municipal organization developed under the Clarke-McNary Section 2 program for the Salt Lake Valley watershed in Utah.

One of the principal advantages of using the equipment developed by the telephone people is that it furnishes a common medium of communication that all cooperators can afford to install. Many cooperators could not afford to invest approximately $1,200 per unit in mobile VHF-FM equipment, but can afford to set up a small budget for seasonal rental of standard telephone equipment from a commercial concern that is devoting its entire program to furnishing the public the communication it demands. Then too, the company takes over responsibility for installation, repair, maintenance, and development. Maintenance alone is an item of considerable expense when equipment is owned outright.

Regardless of whether a cooperator owns his VHF-FM mobile equipment or rents it from a telephone company, there is an initial cost of preparing a motor vehicle to insure sufficient continuing power for a full fire season use. The costs of such installations are about as follows:

Generator, 35 amp. at 10 m. p. h	$40
Power battery, 180 amp	20
Regulator	6
Installation of above	40
Total	106

For the Salt Lake City area the Mountain States Telephone & Telegraph Co. is making the following charges now for installation and rental. As more units are installed these costs should go down.

Cost of initial installation	$25
Rental of equipment per unit	15
Monthly message guarantee allowing up to 40 minutes of calls per month	7

Anything over 40 minutes at rate of 20 cents per 3 minutes.

If a dispatcher system is set up the $7 guarantee is reduced to $2.50 per unit, but there is a $3 charge made for a dispatching terminal.

This development by the telephone people demands investigation, especially where dollars are a big consideration in outfitting a diverse group of cooperators and where VHF-FM reception has sufficient coverage. In Region 4 of the Forest Service two areas where it is especially practical are the Salt Lake Valley protection area and the Reno-Carson area. In the Salt Lake area the cooperative protection force is activated through one common dispatcher. The following list of major cooperators gives some idea of the scope of coverage and the need for good interagency communication:

Salt Lake Water Department
Salt Lake Fire Department
Bountiful Fire Department
Farmington Fire Department
Salt Lake Parks
Salt Lake Police
State Traffic Forces
Salt Lake County Sheriff
State of Utah Highway Department
State Forester
Wasatch National Forest
Utah Power & Light Co.
Mountain States Telephone & Telegraph Co.

Proper correlation of all these organizations results in a communication load which Forest Service facilities probably never would reach. But the vehicle radio-telephone service reaches all mobile and fixed station installations of all cooperators.—J. W. Mattsson, *Forester, Fire Control Region 4, U. S. Forest Service.*

PORTABLE TRACTOR HEADLIGHTS

M. D. Stowell
Fire Control Officer, Plumas National Forest

For several years the need for an emergency set of tractor headlights that could be installed quickly and easily on logging tractors used on fires has handicapped our night control efforts.

The U. C. Lite Manufacturing Co., Chicago, manufactures a portable light, Big Beam #700, that operates on 4 screwpost dry cell batteries. This light fills this need for a light weight readily portable headlight. A bracket to mount this light on tractors was designed by E. E. Kessler, Plumas welder and blacksmith (figs. 1 and 2). This

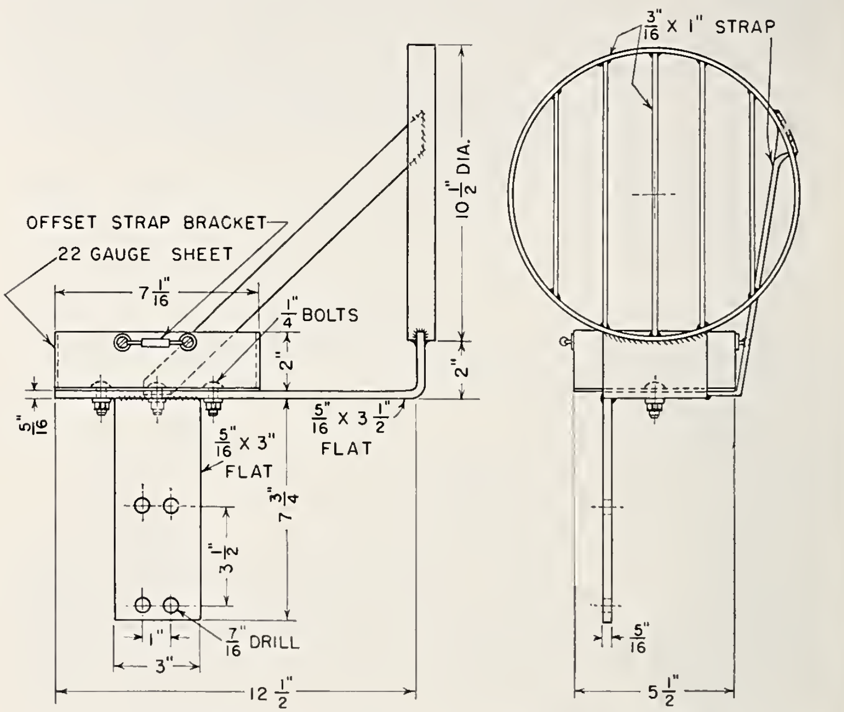


Figure 1.—Bracket for portable battery tractor light.

FIGURE 2.—Portable tractor headlight and bracket, assembled and separate.

bracket can be quickly attached to any caterpillar tractor by merely inserting 4 stud bolts into the tapped holes in the radiator housing designed to hold regular headlight brackets. Tests on fires proved that this light will operate for 6 to 8 hours continuously on one set of batteries. The cost of the light is approximately $18.25.

The bracket can be readily made by any welder and can be installed by anyone. Spare batteries can be carried and quickly installed if longer use of the headlights is desired.

Pocket-Size Fire Control Plans.—The Rhode Island Forest Service has endeavored to make the most and best use of its annual forest fire control plan. Beginning with the spring of 1948, State Forester Jacobson, at the suggestion of Ranger Alton M. Markham (recently deceased), revamped the fire control plan by making a pocket-sized edition. An inexpensive standard 6-ring, 4- by 6-inch binder has been used for cover protection of the loose-leaf plan. Each of the 35 State forest fire wardens has been furnished a copy with his name on the cover. The booklet is labeled "Rhode Island Forest Service—Fire Control Plan." In addition to the text, the most recent forest fire law publication is included.

The advantages of this unique project are at least three-fold:

1. Provides a fire control plan and directory of personnel which can be easily carried in one's pocket.
2. Sections can be amended without making a complete run of the plan.
3. Fire wardens are given a boost in morale by having names printed on individual covers.

Anyone interested may obtain more detailed information of the contents, costs, and the like by writing Mr. Eric G. Jacobson, Chief Forester, Office of Forests and Parks, 18 State House, Providence, R. I.—EDWARD RITTER, *Region 7, U. S. Forest Service.*

DEMOUNTABLE TRANSPORT BED FOR 50-MAN FIRE UNIT

M. O. Adams
Central Dispatcher, Shasta National Forest

The device discussed here was prepared by the Shasta to obviate keeping a loaded truck on stand-by. This Shasta idea prompted the development of a standard slip-on bed for Region 5. Design and specifications should be available soon.

District Ranger L. L. Feight, Fire Control Assistant G. Call, and Prevention Aid K. Mason of the Pit Ranger District developed and put into use a loaded 50-man fire camp unit which has reduced loading time and can be handled by one man with a minimum of effort.

These men constructed a wood bed with stakes, similar to a standard stakeside, out of lumber salvaged from an abandoned sawmill. The complete unit is 11 feet, 7 inches in length, 6 feet, 5 inches in width, and 38 inches high. Six wheels salvaged from safes were mounted between the bed members to aid in loading and unloading. The finished bed has an unloaded weight of 400 pounds and when fully loaded a gross weight that does not exceed 3,000 pounds.

Figure 1.—Transport bed with 50-man fire camp unit on loading platform.

To facilitate loading, a platform, built of salvage lumber, was placed in a warehouse stall. The 50-man unit fully loaded and ready for instant loading onto a truck, is stored on this platform (fig. 1).

The loading platform is 2 feet longer than the transport bed, and the back is 1 inch higher than the front. This slight tilt gives a downhill roll onto a truck. As another aid in loading, salvage metal strips were placed on the platform deck as wheel channels for the transport bed (fig. 2).

FIGURE 2.—Front view of transport bed. Note metal strips on platform deck for wheel channels, and holding wedge.

The loading platform was constructed to the same height as the bed of a Ford stakeside used by the district. When a fire strips the district headquarters of automotive equipment, a private truck can be used to haul the camp unit. Should the private truck bed be higher than the loading platform, holes may be dug in the ground for the rear wheels to lower the bed to the height necessary for loading.

Whenever a call for the 50-man unit is received, the district dispatcher has a truck back up to the loading platform in position to load. The dispatcher then pulls out the holding wedges, which prevent the unit from rolling off the platform when it is stored, and with a pry bar rolls the unit onto the truck. Chains and binders are used to tie the unit to the truck bed.

The time required to load, bind, and start this unit on its way to a fire is 5 minutes. This is much less than the time formerly required, when each piece of camp equipment and line tools were loaded by hand.

Material Carried on the Unit

15 shovels, l. h. r. p.	5 gallons kerosene
15 tools, McLeod	5 gallons oil, motor, S. A. E. 20
15 axes, d. b.	3 brush hooks
5 tools, Pulaski	1 brush knife
3 shears, pruning	3 saws, felling
1 rake, asphalt	3 sledges, 8-pound
12 files, 8-inch	6 wedges, steel
1 torch, Hauck	12 wedges, wooden
48 fusees	1 pump, barrel
50 lamps, electric, head with batteries	2 flame throwers
40 canteens, 1-gallon	5 outfits, back-pack
1 set irons, campfire	1 outfit, first aid, large
1 water heater, Flamo	1 range, Flamo
8 tables, folding	2 cylinders, Flamo
1 outfit, mess, 50-man	1 desk, camp boss
10 knapsacks	4 cans milk, 10-gallon
1 funnel, Coleman	6 lanterns, gas, Coleman
50 bags, sleeping or 150 blankets, bed	300 feet rope, 3/8-inch
2 rolls wire, emergency, single or duplex	1 telephone, portable
	1 outfit, camp boss
1 radio, S set	5 gallons gas, white
15 signs, campfire	1 drum gas, leaded, 50-gallon

After the truck with the 50-man unit arrives at a fire camp and the equipment is unloaded, that truck is then available to haul men or tools from the fire camp to the fire line. When the fire camp is disbanded, the 50-man camp equipment is reloaded into the transport bed and returned to the district headquarters where, by use of a set of blocks, the unit is pulled from the truck onto the loading platform.

All equipment is unloaded, checked, and used articles are replaced. In a short while a complete 50-man unit is again ready to roll to a fire.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustration. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.

The approximate position that illustrations bear to the printed text should be indicated in the manuscript. This position is usually following the first reference to the illustration.